

Assessing the Impact of Chemotherapy Education on Practice Change for Error Prevention:  
A Program Evaluation

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### Abstract

Antineoplastic regimens are complex, with inherent toxicity and narrow therapeutic indices that may result in life-threatening patient harm should an error occur. Chemotherapy nurses need to have specialized knowledge and competence in error prevention and recognition. Additionally, workplace culture, leadership, and policies and procedures must provide support for safe chemotherapy care. This project assessed how completion of a comprehensive chemotherapy course may impact individual and organizational error prevention strategies. Fifteen error preventive nursing behaviors were identified in practice guidelines and standards. These critical behaviors and the organizational processes to support them were addressed in a descriptive, cross-sectional survey that utilized retrospective, self-reported data from 334 registered nurses who completed the course between October 2015 and March 2016. Course content impacted practice with up to 27% of respondents reporting either increased awareness of the need to perform a specific behavior, or that they had initiated change in a specific behavior. Overall, the two nursing behaviors impacted most related to verifying drug-specific dose limits and using generic drug names. Nurses holding professional oncology certification reported a lesser impact on nine of the practice behaviors than non-certified nurses. Organizationally, at least 30% started discussions with colleagues related to policies and procedures. More than 60% encountered at least one barrier to individual and organizational change. This program evaluation was an initial step in exploring knowledge application to practice through behaviors that promote chemotherapy error prevention. Recommendations for practice are: 1) provide comprehensive chemotherapy education for oncology nurses, 2) integrate practice guidelines and standards, 3) assess practice change needs related to critical nursing behaviors, 4) implement organizational processes to support practice change, and 5) prioritize a culture of safety.

## Assessing the Impact of Chemotherapy Education on Practice Change for Error Prevention:

### A Program Evaluation

#### Section One

##### Introduction of the Problem

##### Medication Errors

The Institute of Medicine (IOM), now the National Academy of Medicine (NAM), has issued a series of reports that focus on the prevalence and effects of medical errors on patient outcomes. These reports have heightened public awareness of medical errors, impacted health care policy and health system accreditation, affected reimbursement outcome reporting criteria, provided strategies for error recognition and response, and urged error elimination through system safety initiatives and individual practice change (IOM, 1999a; IOM, 1999b; IOM, 2001; IOM, 2003; IOM, 2004; IOM, 2006; IOM, 2013). One key component of the IOM reports and recommendations is the prevention of medication errors. To provide clarity, the definition of a medication error is, “any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare professional, patient, or consumer” (NCCMERP, 2016, para. 1). Experts estimate preventable medication errors account for more than 7,000 deaths and harm another 1,500,000 patients per year in the United States (U.S.) (Ehlert & Rough, 2013; IOM, 1999b; IOM, 2006).

##### Chemotherapy Errors

Of significance to the oncology environment is the IOM (1999a) notation that error prevention is “particularly important for cancer chemotherapy” (p. 164). A collaboratively developed definition of chemotherapy is used for this project and refers to “any antineoplastic agents used to treat cancer” (Neuss et al., 2013, p. 226) with the exception of hormonal agents.

Practice guidelines and standards, along with health policy recommendations, address drug-specific and patient-specific concerns that may interfere with safe chemotherapy prescribing, admixture, and administration (IOM, 1999a; Neuss et al., 2013; Polovich, Olsen, & LeFebvre, 2014; Shulman, 2015). Patient-specific factors such as advancing age and comorbidities may complicate chemotherapy dosing due to organ dysfunction, and impact treatment effects and response. Cancer disparities including access to care and treatment costs are known to impact patient safety when undergoing treatment for cancer (ASCO, 2016; Edwards & Bencheikh, 2016; IOM, 2013). Lastly, IOM reports have contributed to risk evaluation and mitigation strategies (REMS) for oncologic supportive care agents (Damron & Phillips, 2015).

### **Chemotherapy Error Prevention**

Safe chemotherapy care involves organizational and individual accountability and collaboration between ordering providers, pharmacists, and nurses (Neuss et al., 2013; Shulman, 2015). Healthcare organizations need processes and tools in place to enable appropriate treatment verification and safe administration (Neuss et al., 2013; Shulman, 2015). Clinical guidelines and standards include safe chemotherapy practice recommendations for organizational policy and procedure development (Neuss et al., 2013; Polovich et al., 2014; Shulman, 2015).

The actual incidence of adoption and extent of chemotherapy error prevention strategy integration are unknown, and errors may still occur within any phase of treatment planning and medication administration (Bruce, 2013; Nelson, Moore, Grasso, Barbarotta, & Fischer, 2014; Polovich, Olsen, & LeFebvre, 2014; Shulman, 2015). Choi et al. (2016) also report most medication errors occur or are reported during medication administration. Specific to chemotherapy, the primary type of reported errors are those involving dosing. Although many of these events do not reach the patient, they are often linked to the nurse as a key contributor in

preventing harm to patients through error recognition (Polovich, 2015; Polovich et al., 2014; Shulman, 2015; Walsh, Dodd, & Seetharaman, 2009). *The foremost proactive strategy for chemotherapy error prevention during pretreatment and treatment administration phases is noted within practice guidelines and standards as comprehensive education and subsequent development of chemotherapy competency for nurses.* The recommendation is for initial and ongoing didactic training followed by skill assessment that emphasizes the components of safe chemotherapy administration specific to the context of the care setting (Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014).

### **Chemotherapy Education for Nurses**

The dynamic shift in cancer treatment settings, increasing complexity of treatment regimens, and antineoplastics being administered for non-oncology conditions lead to increasing numbers of nurses needing specialized knowledge to administer hazardous agents and to care for individuals experiencing their harsh effects. Educational interventions aimed at developing chemotherapy-competent nurses enhance the safety and quality of cancer nursing practice. A growing demand exists for chemotherapy nurses to provide safe and competent care to improve the quality outcomes of those with a cancer diagnosis (IOM, 2013). Chemotherapy care requires effective training, critical behavior and skill attainment, and clinical competence as the fundamental bases for safe administration of chemotherapy (Polovich et al., 2014).

**Chemotherapy education through the Oncology Nursing Society.** As a professional association of more than 39,000 members, the Oncology Nursing Society (ONS) provides evidence-based educational programs and advocates for the nursing profession and people with cancer through efforts that address safe care, improve quality of life, and focus on patient outcomes (ONS, 2017a). For more than 15 years, a nationally standardized and comprehensive

chemotherapy course has been offered by ONS. Starting as a live presentation offered by trainers across the U.S. in 1999, the program has evolved into an online certificate course and is a shared initiative developed by ONS and the Oncology Nursing Certification Corporation (ONCC). The course is designed for nurses who have been providing chemotherapy care for more than one year and administer it at least once a month. The purpose of the course is to “prepare and reinforce critical information for safe administration” of chemotherapy (ONS, 2016b, para. 3). Although error prevention strategies are fragmented within course content and the accompanying e-book, the program included a significant amount of content pertaining to safe chemotherapy care, including steps to mitigate errors and adverse events during pretreatment and treatment administration nursing tasks. Course and e-book content are inclusive of the critical role of vigilant nursing behaviors, and the need for underlying organizational policies and procedures that support those nursing behaviors. At the time this project was planned, the course included discussion forums that were facilitated by nurse experts in chemotherapy administration. The error prevention tasks and supporting processes discussed in the course comply with the ONS Chemotherapy and Biotherapy Guidelines and Recommendations for Practice and with the interprofessional practice standards collaboratively developed and endorsed by ONS and the American Society for Clinical Oncology (ASCO) which is the foremost professional association for practicing oncologist physicians (Neuss et al., 2013; ONS, 2015; Polovich et al., 2014).

**ONS/ONCC chemotherapy program evaluation.** At the time this project was conducted, the required elements of the ONS/ONCC course included submission of four discussion postings with facilitator feedback and a score of at least 80% on a multiple choice post-test to measure immediate knowledge retention. A general post-program evaluation determines the learner’s reaction to the educational program goals and process, and one

evaluation question asks participants whether or not they intend to change behaviors by applying course content to practice (ONS, 2016b). *However, there is no further evaluation of the nurse to assesses if practice change has occurred through the application of the knowledge gained from the course into practice, as there is no further follow-up communication with the course participants.*

### **Practice Change and Compliance to Guidelines and Standards**

Practice change occurs as a result of triggered events, sometimes following a negative critical incident, due to knowledge gained from an educational intervention, or when practice guidelines and standards are consulted (Weber & Sidorov, 2014). Guidelines and standards compile and translate high level evidence into concise best practice statements (Weber & Sidoroy, 2014). For this project, error prevention strategies of focus were those recommended in the ONS guidelines (Polovich et al., 2014) and the ASCO/ONS practice standards (Neuss et al., 2013). Of note, the 2013 version of the ASCO/ONS standards was used due to the participants taking the course prior to the release of the 2016 version (Neuss et al., 2013; Neuss et al., 2016).

The desire was to learn how nurses who have successfully completed the ONS/ONCC course perceived the need to change practice to better comply with chemotherapy error prevention recommendations, and whether or not behaviors that impact error prevention were initiated within six months of course completion. The interval of six months was chosen since a general estimate of time from educational intervention to practice change is a minimum of six months, and up to two years (Weber & Sidorov, 2014; Porter-O'Grady & Malloch, 2015).

To further demonstrate the importance of this project, email and telephone inquiries to the ONS staff from nurses who have completed the course often request clarification and evidence in an effort to advocate and support the need for enhancing their personal and

workplace processes for safe chemotherapy care. This may indicate practice change was being attempted and initiated due to program content, both at the individual nursing level and at the unit and organizational levels. *Therefore, a need has been identified for measuring the effectiveness of the ONS/ONCC chemotherapy education program on impacting patient safety through integration of error prevention strategies at the individual and organizational levels.*

### **Barriers to Practice Change**

While the need to identify the impact of education on error prevention strategies was the priority of this project, exploring perceived barriers to practice change was also desired. A published literature review comprised of eleven articles revealed limited knowledge about how the personal and professional aspects of nursing leadership, collaboration, and empowerment may impact patient safety (Richardson & Storr, 2010). The authors highlighted that nurses are the ideal drivers of quality and safety “because of their unique proximity to patients” (Richardson & Storr, 2010, p. 12). In addition to multiple personal factors, such as self-confidence, the context of care and working environment have been found to influence the safety of medication administration. These include proactive versus reactive response to errors, trust in leadership, manager passivity, and inadequate training, guidance, and error reporting (Farg, Tullai-McGuinness, Anthony, & Burant, 2017; Fyhr, Ternoy, & Ek, 2015).

### **Purpose of the Project**

*The purpose of this project was to assess the impact of knowledge attained from a comprehensive chemotherapy course on individual nursing behaviors and organizational processes that are compliant with evidence-based chemotherapy error prevention strategies.* A survey was conducted that reflects course content specific to chemotherapy error prevention at the individual and organizational levels. The survey addressed the course participants’ perceived



need for change and efforts to initiate change that improved compliance with chemotherapy error prevention strategies within practice guidelines and standards.

Data was collected from a subset of registered nurses who successfully completed the ONS/ONCC Chemotherapy and Biotherapy Certificate course between October 1, 2015, and March 31, 2016. The setting for this project was the Education and Research Departments within the ONS national office in Pittsburgh, Pennsylvania.

An observational design guided the project consisting of a descriptive cross-sectional survey that utilizes retrospective, self-reported data obtained through a web-based questionnaire. Survey content was developed based on fifteen recommended individual critical behaviors and their supporting organizational processes for chemotherapy error prevention interspersed in various components of the ONS Chemotherapy and Biotherapy Guidelines and Recommendations for Practice (Polovich et al., 2014) and the ASCO/ONS Chemotherapy Administration Safety Standards (Neuss et al., 2013).

### **Statement of the Clinical Practice Problem**

The use of the Population-Intervention-Comparison-Outcome-Time (PICOT) clinical question format assisted in gaining the most relevant evidence for this project (Fineout-Overholt & Stillwell, 2015). The PICOT problem statement was: ***In nurses who have completed a comprehensive chemotherapy education program, was practice change to increase compliance with evidence-based chemotherapy error prevention strategies initiated within six months?***

### **Summary of Evidence from the Literature**

#### **Literature Search Method**

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist was used to critically appraise the literature following an exhaustive literature search

(Moher, Liberati, Tetzlaff, & Altman, 2009; PRISMA Group, 2009). Three databases were accessed through the Ohio State University (OSU) Health Sciences Library (HSL), including PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Cochrane Library. Other sources include the ONS publications database, UpToDate, Researchgate, and the National Guidelines Clearinghouse. No meaningful limits were placed on the search processes. All data about the incidence of chemotherapy errors and the impact of strategies to minimize chemotherapy errors were desired. The search process involved specifically seeking information about the implementation of medication error prevention strategies and intervention outcomes. The most appropriate strategies and outcomes were those supporting the integration of chemotherapy education, policies, procedures, protocols, and error prevention behaviors as strategies to improve chemotherapy dosing and administration safety.

### **Synthesis of the Evidence**

#### **Tables of Evidence**

Appendix A includes four tables synthesizing the evidence from the exhaustive literature search. Table A1 is a synthesis of studies to determine the incidence of chemotherapy errors. Table A2 shows the evaluation and synthesis of high level relevant expert committee reports, clinical guidelines, and practice standards that integrate evidence, expertise, and patient-specific content. Most encompassed social, ethical, and environmental determinants of cancer care to develop best practice considerations for chemotherapy settings. Included in the synthesis were nine expert reports with systematic reviews, and seven practice guidelines and standards resources. Table A3 provides an evaluation and synthesis of additional supporting literature related to medication and chemotherapy errors, including four systematic reviews, four direct observational studies, four literature reviews, and 20 descriptive studies including case reports,

quality improvement (QI) initiatives, retrospective and prospective record reviews, and exploratory surveys. The tables describe how the studies address factors influencing chemotherapy errors, and the recommendations for error preventive structures, processes, and behaviors. Details within Tables A2 and A3 also include the strength and quality of each piece of evidence, and the feasibility of including the evidence to support this project.

Table A4 is a synthesis of best practice recommendations for chemotherapy error prevention, recognition, and reporting at the system, unit, and individual levels compiled from many of the evidence sources in Tables A1, A2, and A3. Additionally, Appendix B includes Figure B1, showing an evidence-based root cause analysis of chemotherapy errors at the system, unit, and individual levels utilizing an Ishikawa (fishbone) diagram also compiled from sources of evidence in Tables A1, A2, and A3.

### **Critical Appraisal of the Evidence**

Critical appraisal of the evidence presented in Tables A1, A2, A3, A4, and in Figure B1 assisted in validating the potential impact of this project. Firstly, detailed analysis demonstrated the great risk for harm should a chemotherapy error occur and the essentially unknown incidence of chemotherapy errors. Secondly, the literature review provided insight into the causes of chemotherapy errors, interprofessional accountability for error prevention, and recommended individual and organizational strategies aiming to mitigate chemotherapy errors. ***Critical appraisal of the evidence revealed two key needs: 1) chemotherapy error prevention education for nurses, and 2) evaluation of change in practice behaviors and underlying organizational processes to support the nurses' role in preventing, recognizing, and reporting errors.***

### **Chemotherapy and the Risk for Harm**

Patient safety risks due to chemotherapy administration errors have been well documented in the literature. Many systemic agents used to treat cancer have narrow therapeutic indices combined with adverse effects leading to organ toxicity, thereby creating great risk for patient harm should a dosing error be unrecognized prior to administration (ASHP, 2015; Ehlert & Rough, 2013; Gandhi et al., 2005; IOM, 1999b; IOM, 2013; JC, 2005; Keers, et al., 2013; Neuss et al., 2013; Polovich, 2015; Ranchon et al., 2012; Schwappach & Wernli, 2010). The multilevel involvement of staff within organizations combined with the complexity of therapy regimens and essential dose calculations pose significant challenges in cancer treatment planning and administration. Additionally, care may be fragmented due to poor communication and non-integrated medical records between oncology and primary care providers (Shulman, 2015).

Errors that reach the patient may result in poor outcomes and decreased quality of life for the patient, multiple ethical and legal ramifications for the healthcare organizations, and detrimental financial effects for both the patient and healthcare organization (ASHP, 2015; IOM, 1999b; IOM, 2013; JC, 2005; JC, 2016; Keers, et al., 2013; Polovich, 2015; Ranchon et al., 2012; Shulman, 2015). One overdosage miscalculation may lead to unplanned toxicity or even death. An under-dosing error may lead to reduced treatment efficacy and response, possibly impacting the chance for disease remission or cure (Shulman, 2015). However, many errors go completely unnoticed; some may become apparent if the severity of toxicities is unexpected, or if suboptimal treatment outcomes are recognized (Shulman, 2015).

The risk for potentially devastating errors increases in multidrug regimens that are rapidly becoming standard of care, and necessitate the need for critical nursing behaviors with policies and procedures in place to reduce the risk for errors (ASHP, 2015; Baldwin & Rodriguez, 2016;

Ehlert & Rough, 2013; Ford et al., 2006; Gandhi et al., 2005; Harris & Northfelt, 2005; IOM, 1999a; IOM, 1999b; IOM, 2013; JC, 2005; JC, 2016; Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014; Ranchon et al., 2012; Schwappach & Wernli, 2010). While electronic health records and computerized ordering systems help to standardize processes, they often are not integrated between care settings, and fail to eliminate human error (Amato et al., 2016; Shulman, 2015).

### **Chemotherapy Error Reporting**

Within the oncology environment, the American Society for Radiation Oncology (ASTRO) has initiated the creation of a national medical error reporting system. The program focuses “on improving patient safety and reducing the chances of medical errors during radiation therapy treatments” (ASTRO, 2016, para. 2). Pharmacovigilance through chemotherapy error reporting is not advancing as quickly, although the national adoption of systematic transparency and reporting metrics in error reporting is one recommendation of experts. Process measurement that includes safety-related variables is being realized as necessary in many oncology settings. However, while some organizations maintain voluntary, anonymous error reporting systems, there is no widely accepted method for chemotherapy error reporting (ASCO, 2016; Edwards & Bencheikh, 2016; IOM, 2013; Lennes et al., 2016; Shulman, 2015).

Experts suggest the utility of process measures is higher when performance comparisons can be made. Furthermore, this type of benchmarking may be achievable through the support of professional associations and accrediting bodies to mitigate risks and accelerate patient safety outcomes (Lennes et al., 2016; Shulman, 2015). The Quality Oncology Practice Initiative (QOPI®) is a registry offered by the American Society of Clinical Oncology (ASCO) that indirectly includes error prevention strategies within its quality measures (ASCO, 2017).

Similarly, the Oncology Quality Clinical Data Registry (QCDR) offered by ONS includes measures to identify clinical care gaps that may lead to increased focus on error recognition and reporting (ONS, 2017b). Adherence to guidelines and standards is a component of the registries. However, appropriate dosing within chemotherapeutic regimens is not assessed, and electronic records are not linked to assist with dosing accuracy (Blayney et al., 2014; Shulman, 2015).

### **Chemotherapy Error Incidence**

In a retrospective case-controlled study, Choi et al (2016) reviewed more than 57,000 medical records finding that “medication errors occurred at a rate of 0.8 per 100 admissions, or 1.6 per 1000 patient days” (p. 428) with significant financial impact regardless of patient harm. Specific to cancer treatments, the evidence presented in Table A1 reveals great variability in reported rates of chemotherapy errors. With the exact incidence and impact unknown, benchmarking is nearly impossible. While the literature suggests varying incidence rates, some errors are not discoverable due to lack of ongoing monitoring of treatment ordering, preparation, and administration (Neuss et al., 2013; Neuss et al., 2016; Ranchon et al., 2011).

One study by Ford, Killebrew, Fugitt, Jacobsen, and Prystas (2006) suggests oncolytic errors account for up to 15.6% of all drug events. Data indicate between 0.3% and 6% of chemotherapy orders contain some type of error (see Table A1) (Baldwin & Rodriguez, 2016; Schwappach & Wernli, 2010). Error incidence is higher in regimens with more than three drugs or with dose modifications (Ranchon et al., 2012; Shulman, 2015).

Despite the availability of preventive error management guidelines and standards (see Tables A2 and A3), errors are often unrecognized or under-reported. Most are prescriptive or documentation errors recognized before reaching the patient, yet many reported errors are

discovered during critical nursing tasks before and during treatment administration (Polovich, 2015; Polovich et al., 2014; Walsh, Dodd, & Seetharaman, 2009; White et al., 2010).

### **Chemotherapy Error Types and Causes**

Chemotherapy errors can be categorized based error type or factors influencing the error.

**Types of errors.** Types of errors include incorrect drug, dose, route, patient, and day or timing, as well as lack of communicating a change in dose or protocol, and failure to document assessment or laboratory findings that result in missing an important consideration that should have delayed or reduced a dose (Lennes et al., 2016). Choi et al (2016) reported medication errors are primarily manifested in incorrect medication, dosage, and administration time. An observational study conducted by Delpuech, Leveque, Gourieux, and Herbrecht (2015) found 522 drug-specific questions or problems in 4,393 oncology-related prescriptions. Of the identified issues, 11.7% were due to underdosing and 8.9% to overdosing. Specifically related to medication administration, drug omissions accounted for 3.5% and inappropriate administrations for 14.1% of the errors noted in the study.

**Factors influencing errors.** A chemotherapy error is recognized as a multilayered variance, and the evidence for error recognition and prevention can clearly be delineated to include unit-based processes, system-based structures, and critical individual nursing behaviors. While evidence suggests that staff responsible for treatment preparation and administration are prone to mistakes, their errors seem to be greatly influenced by environmental conditions during critical safety-related tasks (Keers et al., 2016; Lennes et al., 2016; Kullberg et al., 2013; Schulmeister, 1999; Surbone & Rowe, 2015). Fyhr et al (2015) identify common problems include lack of training and competency assessment, inadequate guidance and feedback related to procedural tasks, failure to prioritize error prevention, ineffective communication, insufficient

safety barriers, and absence of event reporting mechanisms and risk analyses. Figure B3 depicts a root cause analysis of factors influencing chemotherapy errors in an Ishikawa (fishbone) diagram at the individual, unit, and systems level (ASCO, 2016; ASHP, 2015; CCO, 2012; CCO, 2014; IHI, 2012; IOM, 1999a; IOM, 2013; Keers et al., 2013; Kloth, 2010; Lennes et al., 2016; Nelson et al., 2014; Neuss et al., 2013; Polovich, 2015; Polovich, et al., 2014; Schulmeister, 2006; Schulmeister, 2008; Schwappach & Wernli, 2011; Walsh et al., 2009; Warren, 2014).

***System factors.*** Underlying ineffective system-based structures may be crucial contributors to the occurrence of medication errors, failing to support error prevention. These include lack of ineffective components or issues related to technology infrastructure, compliance with known best practices and recommended error prevention strategies, limited clinical tools and resources, lack of leadership support for error prevention, and not prioritizing the adoption of a safe culture (Farag et al., 2017; Fyhr et al., 2015; Hung et al., 2016; ISMP, 2016b; Richardson & Storr, 2010; Shulman, 2015). For example, a recent review of more than 2,500 medication errors revealed safety issues that include computerized ordering and documentation systems actively contributing to or failing to prevent errors, indicating a change at the systems level is needed to include standardized safety reporting (Amato et al., 2016).

***Unit-based factors.*** The context of each chemotherapy care unit must also be considered. Errors may result due to ineffective detail of error prevention tasks in written processes, inadequate policies and procedures, lack of safety prioritization by managers, insufficient nurse training and assessment for competency in critical behaviors, lack of communication in recognizing and reporting errors, and environmental concerns such as distractions, noise, and interruptions (Farag et al., 2017; Fyhr et al., 2015; Hung et al., 2016; ISMP, 2016b; Polovich et al., 2014; Richardson & Storr, 2010; Shulman, 2015).



***Individual factors.*** Personal behaviors or characteristics of nurses and patients may contribute to errors. For nurses, deficient best practice knowledge, insufficient critical skills, failure to follow or unawareness of safety procedures, time and workload constraints with missed steps, and fear of retribution may be factors (Farag et al., 2017; Fyhr et al., 2015; Hung et al., 2016; ISMP, 2016b; Richardson & Storr, 2010). Overdependence on computerized ordering and documentation systems is another issue, as these require human input and may fail to account for human error (Amato et al., 2016; Shulman, 2015). Patient factors may include lack of engagement, education or comprehension, and the presence of disparities or comorbidities (IOM, 2013; Keers et al., 2013; Kloth, 2010; Lennes et al., 2016; Nelson et al., 2014).

### **Accountability for Chemotherapy Error Prevention**

Accountability for safe and ethical care, including adequate performance of critical skills and behaviors and the responsibility to disclose and investigate errors, are both individual and organizational expectations. Overall organizational culture is key to error reduction, and a shared goal between all levels of staff within an organization should state that errors are reduced as much as possible with the understanding that errors likely will never be eliminated (Benzer, Charns, Hamdan, & Afable, 2017; Schein, 2010; Shulman, 2015). Leaders must demonstrate knowledge and understanding about patient safety practices (IOM, 2013; Porter-O'Grady & Malloch, 2015; Schein, 2010; Shulman, 2015; Weir, 2014). Likewise, leadership and culture may impact the staff's readiness or perception of the need for change based on the type and level of communication, motivation, and resources provided (Benzer et al., 2017). Transdisciplinary and multilevel awareness, attention, and vigilance surrounding error prevention must exist, along with assuring staff are willing and able to report safety issues without fear of punitive action (Fyhr et al., 2015; Porter-O'Grady & Malloch, 2015; Richardson & Storr, 2010; Shulman, 2015;

Surbone & Rowe, 2015). Specific to chemotherapy, pharmacovigilance across levels is important due to the use of high-risk agents with inherent toxicities, and the complex management of patients between care settings (ASCO, 2016; Edwards & Bencheikh, 2016; IOM, 2013).

**Systems level accountability.** Without prioritizing a culture of safety, a system is highly vulnerable to errors (Shulman, 2015). At the systems level, the integral components needed to transform practice and facilitate chemotherapy error prevention are grounded in an environment and culture that cultivate excellence, support staff needs, and prioritize safety to minimize risk and harm (ASCO, 2016; IOM, 2013; Porter-O'Grady & Malloch, 2015; Schein, 2010; Weir, 2014). The literature urges organizations to strengthen the underlying processes that are considered the required drivers of safe chemotherapy administration by developing preventive chemotherapy error management strategies that comply with clinical, regulatory, and reimbursement guidelines and standards to avoid penalties and decrease the risk for catastrophic outcomes (ASCO, 2016; Fyhr et al., 2015; IOM, 1999b; IOM, 2013; Weber & Sidorov, 2014).

**Unit level accountability.** Literature reveals work cultures are often prohibitive to error reporting, evoking fear of retribution and punitive action (Brady et al., 2009; Fyhr et al., 2015; Harris & Northfelt, 2005; Hung et al., 2016; IOM, 2006; IOM, 2013; Schulmeister, 2006; Sheridan-Leos, 2007; Trbovich et al., 2010). The context of each nursing unit along with staff and patient characteristics must be considered. Delivering educational content is likely to be easier in a non-punitive, non-blaming culture where training and experience in error prevention strategies is prioritized (McNab, Bowie, Ross, & Morrison, 2016). Without a true culture of safety at the unit level, factors contributing to errors may be the result of lack of awareness that guidelines exist, attitudes and perceptions of individuals within the healthcare team, lack of

incentives to comply, and level of difficulty to integrate into current practice, policies, and procedures (Hung et al., 2016; Richardson & Storr, 2010; Weber & Sidorov, 2014).

**Individual level accountability: Nursing.** Because error prevention is inherent in professional nursing practice, licensure regulations, codes of ethics, and practice scope and standards cannot be overlooked. Oncology nursing standards (see Table A2) expect individual nurses to be accountable for developing and maintaining competence in the treatment consent process, and demonstrating that competency through pretreatment verification, safe treatment administration, and post-treatment toxicity management (Brant & Wickham, 2013; Neuss et al., 2013; Neuss, et al., 2016; Polovich et al., 2014). With the development of critical behaviors related to error recognition and reporting, nurses demonstrate accountability, fidelity, and veracity while upholding the ethical principles of beneficence and nonmaleficence (ANA, 2015; Brant & Wickham, 2013; Fry, Veatch, & Taylor, 2011; Surbone & Rowe, 2015).

**Individual level accountability: Patient.** The role of the patient in error prevention is gaining attention. Some drug safety and quality improvement experts advocate for innovative assessment and integration of pharmacovigilance that includes assessing for and integrating patient and family engagement in risk communication (Smith & Benattia, 2016). This patient-centric approach is rooted in the incentivization of quality and safety reporting outcomes (AHRQ, 2016; ASCO, 2016; Etchegaray et al., 2016). Patients and family able to identify factors contributing to errors can assist in recommending changes to organizational processes. A study by Etchegaray et al. (2016) revealed patients questioned staff qualifications, safety procedures, and communication issues as factors likely contributing to errors.

### **Chemotherapy Error Prevention Strategies**

Errors continue to be a quality improvement priority due to their high risk for patient harm. Holding assumptions that systems are safe leads to the likelihood for increased errors. Therefore, strategies aimed at continual evaluation of the underlying safety processes and investigation of error events are essential. Ongoing vigilance at all levels within an organization will provide the highest assurance that that safety is prioritized (Shulman, 2015). Lennes et al. (2016) state improvement projects can result in an interprofessional approach to measuring and reporting chemotherapy errors, including policies and procedures to support the needed changes. Evidence-based practice recommendations for error prevention in the literature include the need for adoption of critical individual behaviors to prevent chemotherapy errors, and strong organizational processes to drive the development and utilization of those critical behaviors (ASHP, 2015; IHI, 2012; IOM, 2013; ISMP, 2007; ISMP, 2010; ISMP, 2016a; ISMP, 2016b; Kloth, 2010; Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014).

**Critical individual nursing behaviors.** *For the purpose of this project, critical individual nursing behaviors are essential tasks that promote the prevention of chemotherapy errors as noted in practice guidelines and standards.* These tasks include verifying the patient's identity, height and weight, understanding of the treatment, medication lists, and consent to treat. A detailed review of chemotherapy regimen orders is also an expectation just prior to administration, and should be performed both individually and simultaneously with another chemotherapy-competent individual. Treatment orders are verified for appropriateness of dose, dilution, sequence, route of administration, and duration of treatment based on standardized protocol and regimen information. Administration tasks involve assuring the appropriate route, sequence, and duration, and assessment of the site and patient for immediate complications.

Documentation standards include noting the verification tasks and assessment findings throughout the pretreatment, administration, and post-treatment phases (ASHP, 2015; IHI, 2012; IOM, 2013; ISMP, 2007; ISMP, 2010; ISMP, 2016a; ISMP, 2016b; Kloth, 2010; Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014).

**Supporting organizational processes.** *For the purpose of this project, organizational processes include policies, procedures, documentation standards, and quality improvement monitoring that promote and support the prevention of chemotherapy errors.* Underlying organizational processes, such as technology infrastructure, policies, and procedures must support error prevention and reduction strategies across the organization. The essential processes noted in practice guidelines and standards include institutional requirements for chemotherapy training with competency assessment. Policies and procedures also need to consider sufficient patient information access and order verification resources, medical record documentation stipulations, quality improvement monitoring, error reporting procedures, and performance appraisal processes (ASHP, 2015; IHI, 2012; IOM, 2013; ISMP, 2007; ISMP, 2010; ISMP, 2016a; ISMP, 2016b; Kloth, 2010; Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014).

### **Chemotherapy Error Prevention Education for Nurses**

A clear gap identified relates to how error prevention information shared through a chemotherapy course is translated into individual practice and organizational process change. Providing comprehensive education, regular competency evaluation, and simulation of error events are recommended tools for raising awareness of critical behaviors and processes that can enhance the safety of practice (Daupin, Atkinson, Bedard, Lebel, & Bussieres, 2016; McNab et al., 2016; Polovich et al., 2014; Neuss et al., 2013; Neuss et al., 2016). This project was an initial step in evaluating the need for, and appropriateness of, error prevention education for patient

safety enhancement. Additionally, the project sought to determine perception of barriers to changing practice at the individual and organizational levels.

The ONS/ONCC Chemotherapy and Biotherapy Certificate course addressed in this project is an established nursing education program. Components of the course address safe chemotherapy administration through evidence-based error prevention strategies compiled from practice guidelines and standards. Each participants' initial reaction to learning and knowledge retention were evaluated after didactic presentation of the course content (ONS, 2016a). This project furthered the program evaluation to assess integration of knowledge into practice.

### **Barriers to Practice Change**

While the need to identify the impact of education on error prevention strategies was the priority of this project, perceived barriers to practice change were also explored. A published literature review comprised of eleven articles reveals limited knowledge about how personal and professional aspects of nursing leadership, collaboration, and empowerment may impact patient safety (Richardson & Storr, 2010). The authors opine that nurses are the ideal drivers of quality and safety "because of their unique proximity to patients" (Richardson & Storr, 2010, p. 12).

**Safety culture.** According to a survey from the Agency for Healthcare Research and Quality (AHRQ) (2016), about 45% of hospital employees perceive their organization reacts to errors in a nonpunitive manner. A recent survey of 246 registered nurses explored how the safety climate of a workplace may impact safe medication practices (Frag, Tullai-McGuinness, Anthony, & Burant, 2017). In addition to multiple personal factors, including self-confidence, the context of care was found to influence the safety of medication administration. Trust in the organization and perceived leadership passivity were reported as possible hindrances to safe practice development and error reporting (Frag et al., 2017).

**Approach to errors.** Supporting infrastructure must include technology, training, policies, and procedures that prioritize safety. Emphasis should be placed on reliable electronic resources and error-reducing systems, and error reporting that is elevated appropriately (AHRQ, 2016). A survey conducted by Hung, Chu, Lee, and Hsaio (2016) suggests safety may be threatened when managers and peers perceive a nurse who reports an error to be incompetent or causing trouble, possibly resulting in the under-reporting of medication errors or limited willingness to report them (Hung et al., 2016).

Fyhr et al. (2017) iterate that both a reactive and proactive safety approach are important organizational components that affect safe practice. However, a proactive approach communicates that leaders have prioritized safety, through training, guidance, communication, and error reporting. With a proactive approach, nurses may have an enhanced sense of resilience, which is especially important with increasingly complex scenarios, such as chemotherapy care, in which safety risks are elevated and error prevention is vital (Fyhr et al., 2017).

## Section Two

### Theoretical Basis

#### Theoretical Frameworks

For the purpose of this project, the New World Kirkpatrick Model of Evaluation (NWKM) (Kirkpatrick Partners, 2015) provided an opportunity to address the impact of knowledge by assessing whether individual practice behavior and supporting process changes were perceived as needed or were initiated following chemotherapy education. Since the NWKM does not assess challenges to changing practice, the Knowledge-to-Action framework (KTA) (Graham et al., 2006) was used to address barriers and facilitators to knowledge integration based on the context of the practice environment and specific stakeholder considerations.

*Following the concepts in the NWKM and KTA frameworks, the project survey themes (See Table A5) assisted in describing how knowledge, critical individual nursing behaviors, and supporting organizational processes may be applied to chemotherapy error prevention.*

#### New World Kirkpatrick Model of Evaluation

The NWKM development is based on an organization's desire to evaluate how training impacts job performance and outcomes. Assessing the impact of critical behavior change and application of knowledge that demonstrates desired compliance with practice guidelines and standards following a training intervention is recognized as a high level educational outcome based on the four levels of evaluation within the NWKM (Kirkpatrick Partners, 2009).

**NWKM evaluation levels.** Within this model, Level One evaluation assesses the participant's reaction to the learning process and information presented. Level Two evaluation assesses learning based on retention of knowledge presented. *The NWKM Level Three assesses if behavior change occurs as a result of applying the knowledge gained to improve work-*



*related outcomes.* Level Four assesses actual work-related outcomes resulting from the applied behavior changes (Kirkpatrick & Kirkpatrick, 2006; Kirkpatrick Partners, 2009).

**NWKM Level Three.** For the purpose of this project, the NWKM evaluation level of focus is Level Three. Level Three determines “how much transfer of knowledge” and “what change in behavior” occurs after training when the participants return to work (Kirkpatrick & Kirkpatrick, 2006, p. 52). Level Three also evaluates facilitators and barriers to behavior change that drive knowledge integration, including “processes and systems that reinforce, encourage and reward performance of critical behaviors on the job” (Kirkpatrick & Kirkpatrick, 2006, p. 52). The NWKM rationale for evaluating at Level Three is that optimal outcomes cannot be achieved “unless a positive change in behavior occurs” (Kirkpatrick & Kirkpatrick, 2006, p. 61).

In chemotherapy error prevention education, Levels One and Two verify knowledge of guidelines and standards has been retained through full attendance at a comprehensive program that includes learner assessment through completion of discussion postings and a post-test. However, organizational goals and objectives to improve safe practice behaviors leading to prevention of chemotherapy errors and the resulting patient outcomes cannot truly be attained unless learning is applied to practice. Additionally, individual behaviors need organizational processes that support training and its application to practice, both of which comply with guidelines and standards. Moreover, participants are positioned to influence change, yet barriers may exist that should be identified to promote the next step of developing tools to overcome barriers and facilitate change (Kirkpatrick & Kirkpatrick, 2006).

A detailed look at Level Three of the NWKM as it applies to this project assesses the effect of learning on critical behaviors, required drivers, and on-the-job learning. Essentially, the components of Level Three describe accountability for learning, and how knowledge is applied

to practice through critical behaviors once the learner returns to the workplace, and how the organization is supportive with required processes to drive the needed change.

***Critical behaviors.*** Critical behaviors are defined in the NWKM as, “specific actions, which, if performed consistently on the job, will have the biggest impact on the desired results” (Kirkpatrick Partners, 2015, p. 7). ***For this project, the critical individual nursing behaviors are strategies previously identified in evidence-based clinical guidelines, practice standards, and best practice recommendations that assist the nurse in achieving optimal chemotherapy error prevention.***

***Required drivers.*** The NWKM also recognizes the need for required drivers or processes that the organization implements to assist in applying the critical behaviors to practice. Required drivers are defined in the model as, “processes and systems that reinforce, monitor, encourage and reward performance of critical behaviors” (Kirkpatrick Partners, 2015, p. 7). ***For this project, the required drivers are considered organizational processes and include the foundational policies and procedures that support the prevention of chemotherapy errors.***

***On-the-job learning.*** The NWKM purports that on-the-job learning includes the expectations that individuals are responsible for maintaining the learned knowledge and skills, and employers support and share in the responsibility for optimal performance (Kirkpatrick Partners, 2015). The NWKM includes steps to successfully determine whether knowledge is applied to practice. ***For this project, individual accountability is demonstrated through application of practice-based critical nursing behaviors which are supported by the organizational processes to prevent chemotherapy errors.*** Additionally, the Knowledge-to-Action framework, discussed later, describes the phases of knowledge translation to practice.

**NWKM evaluation steps.** The steps involved in a NWKM Level Three evaluation are to define expectations of job performance, link learning to work-related tasks, and assess integration of knowledge into work-related behaviors. The model recommends allowing time for behavior change to take place, with three to six months being most realistic. Lastly, the NWKM suggests using well-designed interviews or surveys should provide data to determine if behavior and process change occurred following training. Furthermore, the NWKM description of options for Level Three evaluation include the use of online forms to measure whether distant learners have been involved in change processes (Kirkpatrick & Kirkpatrick, 2006). *For this project, the NWKM Level Three evaluation is demonstrated by defining expectations related to error prevention tasks, and assessing the integration of knowledge into practice through the use of a web-based survey that describes behavior and process change following training.*

**Model application to knowledge in health care.** The NWKM is an outcome-oriented evaluation model that emphasizes learning outcomes directly related to a training program. It focuses on how the knowledge is used by the learner (Dubrowski & Morin, 2011). The NWKM has been adapted to address practice outcomes following education of healthcare professionals (Cox, Seymour, & Stefanidis, 2015). All four evaluation levels have been utilized to measure the effectiveness of various types of healthcare training, assessing training on multiple levels that include learner reaction, knowledge retention, behavioral change, organizational impact, and return-on-investment (Salas et al., 2009). However, fewer than 40 percent of the literature that describe the model applied to practice address behavioral changes or Level Three (Cox, Seymour, & Stefanidis, 2015; Onyura et al., 2016). Literature describing healthcare quality improvement initiatives and program evaluations that utilize Level Three of the NWKM emphasize the need for progression from learning and retention of knowledge to changed

behavior within the clinical setting. At Level Three, the primary stakeholders are the learners and healthcare organizations (Dubrowski & Morin, 2011).

Practice-based competency assessment within the literature include examples of how the NWKM Level Three evaluation has been applied to evaluate knowledge translation to practice in healthcare. The NWKM has been utilized to evaluate pain management curricula and clinical competence related to procedural knowledge of healthcare professionals (Dubrowski & Morin, 2011). Dewey, Ghulyan, and Swiggart describe using the NWKM to effectively evaluate translation of knowledge to practice for providers who completed an educational program and were able to align prescribing processes of controlled substances with clinical practice guidelines and standards (2015). A study demonstrating improvement in knowledge, attitude, and behaviors with intent to improve practice is documented by Goucke, Jackson, Morriss, and Royle (2015). Roos et al. (2014) suggest that peer-, self-, and expert-assessment indicated a transfer of learning into professional practice performance and helped to identify incentives and barriers as well as motivation for change. A systematic review of the use of the Kirkpatrick Model evaluation levels in medical education by Leslie et al. (2013) found 21 healthcare program evaluation studies in which the most commonly reported outcome was participants' behavior change, or Level Three evaluation with outcome indicators including work delivery, skills, and productivity. The same review article identified the majority of program evaluations included self-reported behavior outcomes through interview or survey designs (Leslie et al., 2013).

### **Knowledge-to-Action Framework**

The Knowledge-to-Action (KTA) framework includes two components: 1) Knowledge Creation, in which content of the desired knowledge is generated, provided, and synthesized; and 2) the Action Cycle in which problem-specific processes are followed leading to the translation

and application of knowledge (Graham et al., 2006). Knowledge Creation and the Action Cycle impact each other and may be completed sequentially or simultaneously. *Because the knowledge has already been generated, provided, and synthesized through participant involvement and successful completion of the chemotherapy educational program, the KTA Action Cycle was utilized for this project. The Action Cycle appropriately includes specific needs of the involved stakeholders (learners and organizations) and recognition of barriers and facilitators with knowledge integration; this may also help identify potential tools that assist with error prevention guideline and standard implementation within the practice environment.*

**KTA Action Cycle phases.** The Action Cycle encompasses seven phases that lead to the actual implementation of knowledge, with the first five phases being appropriate for this project, as described below (CIHR, 2014; Field, Booth, Ilott, & Gerrish, 2014).

***Phase One: Identify the Knowledge-To-Action gaps.*** Identifying the gaps in applying knowledge to practice is the basis of knowledge implementation. Learning needs assessments and questionnaires help to identify these gaps (CIHR, 2014).

***Phase Two: Adapt knowledge to local context.*** Although guidelines and standards provide evidence-based practice recommendations, the adaptation of guidelines is a necessity based on the context of each practice environment. Individualizing guidelines to align with organizational goals may help improve acceptance, adherence, and performance (CIHR, 2014).

***Phase Three: Assess barriers to knowledge use.*** During the individualization process in Phase Two, barriers to knowledge use are likely to be identified. The KTA Action Cycle suggests using expert consensus to determine appropriate guidelines and standards for a care setting, and a questionnaire or interview process to gather data regarding factors affecting guideline implementation (CIHR, 2014).

***Phase Four: Select, tailor, and implement interventions.*** Interventions addressing the facilitation of knowledge into practice may include educational programming, quality initiatives, and clinical support tools. Assessing for the presence and need for these options may be helpful in improving compliance with practice guidelines and standards (CIHR, 2014).

***Phase Five: Monitor knowledge use.*** Initial use of knowledge may be attitudinal or conceptual, eventually resulting in demonstration of knowledge use through behavior change. Strategic use of knowledge through quality improvement can then be demonstrated to enhance supporting organizational processes (CIHR, 2014).

**Model application to knowledge in health care.** The KTA framework has been used in various healthcare disciplines to evaluate practice change as a result of research or education integration (CIHR, 2014). A systemic review notes KTA as one of the most frequently cited conceptual frameworks for knowledge translation, and the Action Cycle is primarily used in studies evaluating barriers and facilitators within work environments and stakeholder groups (Field, Booth, Ilott, & Gerrish, 2014). Specific to nursing, the Action Cycle of the KTA framework has been utilized to propose the integration of patient decision support into nursing education (Stacey, Higuchi, & Menard, 2009). Bjork et al. (2013) used the KTA framework to assess how nursing skill performance is measured, and barriers to correct skill utilization. Additionally, Petzold, Korner-Bitensky, & Menon (2010) assessed the use of educational focus groups and interviews to address barriers and facilitators to interprofessional practice change.

### **Recommendations Summary for Program Evaluations**

#### **Current Program Evaluation Process**

At the time of this project implementation, the post-program evaluation process for the ONS/ONCC Chemotherapy and Biotherapy Certificate course measured the learner's initial

reaction. Evaluation questions asked participants to rank the extent to which the course met stated goals and objectives. The evaluation also asked participants to rate the effectiveness of the online platform and teaching-learning strategies. The data gathered from the post-program evaluation correlates with Level One of the NWKM and Phases One and Two of the KTA framework, evaluating learner reaction to educational content (CIHR, 2014; Field et al., 2014; Kirkpatrick Partners, 2009). Additionally, the course required completion of a post-test to evaluate retention of the knowledge. Successful completion of the post-test (a score of at least 80%) is associated with Level Two evaluation of the NWKM (Kirkpatrick Partners, 2009).

### **Program Evaluation Needs**

At the time of this DNP project implementation, the ONS/ONCC program evaluation process did not assess for perceived or actual initiation of change based on knowledge gained, or the course participants' perception of barriers to change. This project involved evaluating higher level educational outcomes based on the NWKM and KTA frameworks, addressed gaps related to applying knowledge to practice, and considered the context of the chemotherapy care setting. This project also identified needs related to the development of critical nursing behaviors and supporting organizational processes by assessing barriers to change. This evaluation correlates with Level Three of the NWKM, and Phases Two, Three, Four, and Five of the KTA framework (CIHR, 2014; Kirkpatrick & Kirkpatrick, 2006). Primary stakeholders in this higher level evaluation process included the nurse learners and organizational decision-makers, both charged with adopting behaviors and processes to promote optimal patient safety.

### **Overall Program Evaluation and Project Survey Themes**

The identified clinical problem for this project was to determine if nurse participants perceived the need to change or if they actually initiated practice change following education to

more effectively comply with specific evidence-based chemotherapy prevention strategies presented in the ONS/ONCC course. The clinical question, *In nurses who have completed a comprehensive chemotherapy education program, was practice change to improve error prevention initiated within six months?* guided the development of the survey components within this project. The answer to the question sought to determine nurses' perception specifically related to the implementation of evidence-based critical behaviors and organizational processes that reduce the potential for chemotherapy errors. Table A5 delineates the appropriate components of the NWKM and phases of the KTA framework that assess change in critical nursing practice behaviors and supporting organizational processes to comply with error prevention strategies presented in the ONS/ONCC chemotherapy course. Specific survey components align with the clinical questions, addressing the following overall three themes.

- Nurse participants' perception of need for individual and organizational change.
- Nurse participants' initiation of individual and organizational change.
- Nurse participants' perception of barriers to individual and organizational change.

### **Utility and Feasibility of Program Evaluation for Practice Change**

Identifying the gaps in applying knowledge to practice is the basis of knowledge implementation. Learning needs assessments help to identify these gaps. ONS evaluates learning needs through questions about desired topics of interest in post-program evaluations and anecdotal conversations with new chemotherapy nurses and chemotherapy-competent nurses. Email submissions to ONS staff also demonstrate a need for guidance when integrating knowledge gained into policies, procedures, and practice.

One of the identified learning needs involves providing education specifically addressing error prevention behaviors for point-of-care staff, and guiding the development of organizational



structures and processes that support those behaviors. The importance of this need is emphasized through the expectation of compliance with guidelines and standards that reduce the risk for medication errors. Furthermore, demonstration of alignment with guidelines and standards is an expectation of some accreditation, reimbursement, and regulatory agencies such as the ONS, American Society for Clinical Oncology (ASCO), Joint Commission (JC), U.S. Department of Health and Human Services (USDHHS) through provisions set forth in the Affordable Care Act (ACA), and reports from the National Academies (formerly the Institutes of Medicine or IOM), (IOM, 2013; JC, 2016; Neuss et al., 2013; Polovich, Olsen, & LeFebvre, 2014; USDHHS, 2014).

At the time of this project implementation, the identified learning need for chemotherapy error prevention strategies was being addressed through content interspersed in various areas and activities within the ONS/ONCC course. However, the effective use of knowledge attained from the course to inform the need for change at the individual and organizational levels was not known. Used of the NWKM and KTA frameworks in this project helped to identify the effectiveness of the course and further educational needs that may assist nurses and organizations in complying with guidelines and standards for safe chemotherapy administration.

### Section Three

#### Recommendations for Practice Change to Prevent Chemotherapy Errors

This clinical inquiry assessed the impact of chemotherapy education for nurses on practice behaviors that minimize the risk for errors, thereby improving patient safety. Of high importance to this project was the appraisal of the evidence suggesting that, 1) most chemotherapy errors occur during prescriptive or order documentation, 2) most errors are recognized before reaching the patient, 3) most are typically the result of underlying system factors, and 4) many are discovered during critical nursing tasks in the pretreatment phase. These four findings in the literature pinpoint nurses as vitally important in error prevention (Keers et al., 2013; Polovich, 2015; Polovich et al., 2014; Shulman, 2015; Walsh et al., 2009; White et al., 2010). *Based on the critical appraisal of evidence and analysis of gaps, five practice recommendations are proposed to enhance and support the nursing role in chemotherapy error prevention as encompassed within the survey themes and components.*

#### Recommendation One: Provide Comprehensive Chemotherapy Education for Nurses

The most apparent notation gained from the literature leading to recommendations for change through implementation of this project is that educational and supportive needs of nurses to provide vigilant and safe chemotherapy care cannot be understated (Neuss et al., 2013; Polovich, 2015; Polovich et al., 2014). The outcomes of this project describe the importance and impact of a comprehensive chemotherapy education program on nursing practice. Any perceived need for change in error prevention behaviors and organizational processes that are essential to support those behaviors, demonstrate the need for initial and ongoing chemotherapy education.

**Recommendation Two: Integrate Practice Guidelines and Standards**

Methods for integrating strategies that promote chemotherapy error prevention in nursing practice are unclear in the literature. Some studies report improved compliance to guidelines and standards in addition to decreased medication error rates following electronic order and documentation implementation that include components of guidelines and standards (ASCO, 2016; ASHP, 2015; CCO, 2012; CCO, 2014; Keers et al., 2013; Kloth, 2010; Lennes et al., 2016; Nelson et al., 2014; Walsh et al., 2009; Warren, 2014; Weber & Sidorov, 2014). In anecdotal reports through inquiries to ONS, nurses frequently seek guidance when faced with unclear order verification processes in the workplace and when attempting to make recommendations for policy and procedure revision to practice leaders. Practice guidelines and standards stipulate the various components of chemotherapy orders, yet chemotherapy nurses continue to identify and verbalize gaps between the error prevention evidence presented in the ONS/ONCC chemotherapy course and what actually is supported and recognized as essential in practice. These gaps suggest the need for evaluating whether standardized policies, procedures, and processes specific to chemotherapy settings comply with practice guidelines and standards, and if educational opportunities regarding the guidelines and standards may assist with their integration. This project describes whether nurses who have participated in a comprehensive chemotherapy education program perceived essential chemotherapy error prevention strategies as already in place, if integration is needed, if change is initiated to allow the integration to proceed, and potential barriers to the integration.

**Recommendation Three: Assess Need for Practice Change Related to Critical Behaviors**

The oncology environment changes rapidly, and treatment for cancer entails multiple patient safety issues due to complex chemotherapy regimens. Nurses are the last checkpoint prior

to the administration of high-alert antineoplastic agents that require special handling and have narrow therapeutic indices with an increased risk for a life-threatening event should an error occur. Individual nurses hold responsibility to accept, adopt, advocate for, and embrace change that promotes evidence-based practice and optimization of safe care (Brant & Wickham, 2013; Polovich, 2015; Polovich et al., 2015). They must practice and model critical safety behaviors, and request revision of essential organizational processes that do not comply with safe practice recommendations (AACN, 2006; Brant & Wickham, 2013; IOM, 2013; Polovich, 2015; Porter-O'Grady & Malloch, 2015; Schein, 2010). A noticeable gap exists between attaining and applying knowledge to prevent chemotherapy errors suggests the need for a more standardized approach to educating nurses with enhanced support through organizational error prevention processes. Therefore, this project was beneficial in determining how education affects the application of error prevention knowledge.

#### **Recommendation Four: Implement Organizational Processes to Support Practice Change**

A chemotherapy error is an undesirable outcome that requires investigation at all organizational levels. At the systems level, change may be needed for quality improvement, risk reduction, and standards compliance. A significant error may diminish patient outcomes, cause undesirable public attention and financial effects, increase insurance costs, and impact the psychosocial status of staff and patients. The integral components needed to transform practice and facilitate error prevention are grounded in a culture that prioritizes safety to minimize harm (ASCO, 2016; IOM, 2013; Porter-O'Grady & Malloch, 2015; Schein, 2010; Weir, 2014).

A root cause analysis (See Figure B1) identifies potential factors contributing to chemotherapy errors within various organizational levels. Structures and processes should integrate evidence-based recommendations for error prevention, recognition, and reporting. An

innovative system approach is the desired result, complying with clinical, regulatory, and reimbursement standards to avoid penalties and decrease the risk for catastrophic outcomes (ASCO, 2016; IOM, 2013).

### **Recommendation Five: Prioritize a Culture of Safety**

The safety climate within a healthcare organization may impact safe medication practices. Remembering to learn from past mistakes is a barrier to improvement because “when harmful events are forgotten, they are likely to be repeated” (Macrae, 2016, p. 1). A prioritization on patient safety should be adopted, including leadership support and integration of strategies to increase empowerment, awareness, and proactive recognition of errors (Fyhr et al., 2015; Hung et al., 2016). Assessing and assuring nurses’ competence and confidence related to error identification, and having trust in the reporting procedure are crucial. These are achieved through education, technology and equipment training, with solid design of policies and procedures that clearly demonstrate patient safety is a priority (Faraq et al., 2017; Hung et al., 2016).

## **Project Implementation Based on Recommendations**

### **Organizational Mission and Strategic Plan**

By assessing practice change following an ONS educational intervention, this project aligns with the ONS mission, vision, and values that guide organizational activities (ONS, 2017a). The ONS mission to advance excellence in oncology nursing and quality cancer care and its vision to lead the transformation of cancer care are encompassed in the provision of comprehensive chemotherapy education. The ONS core values of providing an innovative learning opportunity, promoting excellence in oncology nursing and quality patient care, and advocating for people with cancer are relevant to this project (ONS, 2017a). Furthermore, the theoretical models that guided this project promote high level educational outcomes, outlining

steps for evaluating the effect of training on practice behaviors and delineating the phases of, and potential barriers to, knowledge integration to effect practice change. The recommended practice changes may improve patient safety outcomes through better chemotherapy error prevention.

### **Evidence-Based Practice Model to Implement Change**

Within the series of IOM reports that revealed major variances in care leading to significant preventable harm, recommendations were included. A key recommendation was to enhance evidence-based practice, or EBP (IOM, 1999a; IOM, 1999b; IOM, 2001; IOM, 2003; IOM, 2010). Specific to nursing, an improvement recommendation focuses on the application of knowledge and research to practice, demonstrating EBP (Stevens, 2013). The EBP process involves appraising the current state of knowledge regarding a specific clinical issue to develop interventions that support and improve care processes and patient outcomes. Identifying and implementing best practices to inform safe, quality care is inherent in EBP.

The Evidence-based Advancing Research and Clinical Practice through Close Collaboration (ARCC©) Model (see Figure B4) provides a framework for system-wide use when implementing and sustaining a culture that supports EBP and achievement of quality outcomes. The ARCC© Model is intended to enhance the organizational culture and individual clinicians' beliefs, knowledge, skills, and resources related to EBP, leading to improved and sustainable patient outcomes (Melnyk, 2012; Melnyk & Fineout-Overholt, 2015; Melnyk, Fineout-Overholt, Gallagher-Ford, & Stillwell, 2011; Melnyk et al., 2017). When evidence-based care is “delivered in a context of caring and in a supportive organizational culture, the highest quality of care and best patient outcomes can be achieved” (Melnyk et al., 2011, p. 57).

Central to the integration of the ARCC© Model is cultivation of a culture that promotes evidence-based decisions through the effective use of resources, education, and skill attainment,

and identifies EBP champions and mentors (Dang et al., 2015; Melnyk, 2012; Melnyk, Fineout-Overholt, Gigglesman, & Choy, 2017; Melnyk, Fineout-Overholt, Gigglesman, & Cruz, 2010).

Both individual and organizational EBP implementation are addressed within the ARCC© Model, including barriers and facilitators to change within the context of the care environment, aligning it well with this project. The ARCC© Model cites cognitive behavioral theory (CBT) as a foundation for EBP implementation, specifically focusing on individual nurse perceptions about the importance and value of practice change to improve outcomes and how organizational leadership provides support for the change process (Dang et al., 2015; Melnyk, 2012).

The ARCC© Model is an appropriate pathway to EBP when approaching chemotherapy error prevention. It is widely used by interprofessional teams with EBP champions to implement safety-related protocols in acute care and community organizations. It has also been identified as a key point-of-care improvement model for addressing patient safety in high-reliability organizations (Melnyk, 2012; Melnyk, Fineout-Overholt, Gigglesman, & Choy, 2017; Melnyk, Fineout-Overholt, Gigglesman, & Cruz, 2010). The model depicts a decision tree based on problem exploration and prioritization based on strengths and weaknesses, and progresses toward translating evidence to inform a practice change and improve outcomes (Dang et al., 2015).

The steps of the EBP process are embedded in the ARCC© Model: 1) cultivate a spirit of inquiry, 2) ask PICOT-formatted clinical questions, 3) search for the best evidence, 4) integrate the evidence into practice change decisions while considering clinical expertise and patient preference, (5) evaluate the outcome of the practice change; and (6) disseminate the outcomes (Dang et al., 2015). This project addresses the first four steps of the EBP process, along with dissemination of findings. *For the purpose of this project, initial ARCC© Model steps of assessing organizational culture and readiness for EBP, identifying major barriers to EBP,*

*and exploring clinicians' perceptions about a specific safety-related practice change are being addressed. This initial data can be helpful in determining subsequent steps specific to organizational implementation of EBP.* The project may lead to the development of education and tools to assist with full integration of the practice change recommendations and further studies to describe the impact of changes on safety and quality outcomes (Dang et al., 2015; HRSA, 2011; Melnyk, 2012; Warren, 2014).

### **Project Design and Methods**

#### **Sample**

Data was collected from a subset of registered nurses who completed the ONS/ONCC Chemotherapy Biotherapy Certificate Course between October 1, 2015, and March 31, 2016. The survey was conducted between October 31, 2016, and December 16, 2016. This time period was selected since evidence suggests practice change following the accumulation of knowledge from educational interaction generally takes at least six months and up to two years to achieve depending on the work environment and change intended to be made (Weber & Sidorov, 2014).

**Sampling design.** A convenience sample was used consisting of registered nurse participants who reside in the U.S. and have successfully completed the ONS/ONCC course within the stated six month time frame. Through the use of questions specific to personal and professional practice characteristics, this convenience sample allows for identification of trends and relationships in applying knowledge to practice among different groups of nurses who are administering chemotherapy in a variety of care settings.

**Sample size.** More than 50,000 registered nurses completed the ONS/ONCC Chemotherapy Biotherapy Certificate Course between January 1, 2014, and June 30, 2016. Not all of these nurses are ONS members. Historical data from this course indicates between 82-97%



of participants successfully complete the program based on course requirements (ONS, 2017b). The number of international nurses taking and completing the course is not yet known but is expected to be < .05% of the total number of course participants (ONS, 2017b). Therefore, the total number of course participants within the ONS database is approximately 39,000-45,500. Since the invited project participants completed the course over a specific six months, the number of eligible participants was 5,471.

**Sampling procedure and inclusion.** The secure program evaluation system currently in use by the ONS was utilized to identify registered nurses who have successfully completed the course during the specified six month time period from October 1, 2015, through March 31, 2016. Course requirements that determined successful completion of the ONS/ONCC course during that time frame were, 1) submission of four discussion postings, and 2) obtaining a score of 80% or higher on the course post-test. The usual successful pass rate for this course is 83-89% of participants (L. Richardson, personal communication, October 17, 2016). Those not achieving successful completion requirements were not eligible to participate in this project, and were not identifiable in the program evaluation database. While the course is available globally, only nurses practicing in the U.S. were included since the practice guidelines and standards addressed in the survey are those established and recognized in U.S. oncology settings.

The secure, integrated customer database currently in use by the ONS provided participant email addresses what were de-identified for other components of identification prior to being available to this DNP student. One initial invitation to participate in a web-based survey questionnaire was sent by email to all eligible nurse at the same time, with three reminders sent to non-participants two, four, and five weeks after the initial invitation. The survey was available for six weeks then closed to further responses. The survey was administered by ONS staff.

## **Practice Setting and Context**

The setting for this project was the Education and Research Departments within the national office of the ONS in Pittsburgh, PA.

## **Survey Design**

An observational design guided the integration of the five recommendations for practice change into a descriptive cross-sectional survey that utilized retrospective, self-reported data obtained through a web-based questionnaire.

**Survey development: Critical behaviors and supportive processes.** No standardized tool exists for measuring practice change behaviors and processes aimed at the prevention of medication errors or chemotherapy errors. Survey questionnaire content was developed from recommended error prevention behaviors and supporting policies and procedures that were provided throughout the comprehensive course (See Appendix C). The questions developed were based on key national guidelines and practice standards for chemotherapy error prevention, specifically found within the ONS Chemotherapy and Biotherapy Guidelines and Recommendations for Practice (Polovich et al., 2014) and the 2013 version of the ASCO/ONS Chemotherapy Administration Safety Standards (Neuss et al., 2013).

**Survey development: Barriers to practice change.** The Alberta Context Tool (ACT) (See Figure B5) is a brief survey tool that addresses eight dimensions of complex care settings comprising ten organizational context, or environmental forces, that affect practice behaviors. Organizational context is widely considered to be an important contributor to the integration of evidence into practice (Squires et al., 2013; Squires et al., 2015). The domains measured by the ACT are modifiable and include organizational infrastructure and processes, such as goals,

policies, and procedures related to leadership, culture, performance, informal and formal interactions, and electronic, human, and space resources (See Table A6) (Squires et al., 2014).

The ACT is designed to measure healthcare workers' perception of how evidence is integrated into practice and how the integration is facilitated based on the context of the care setting, describing the association between organizational context and reported use of evidence in practice (Squires et al., 2014). The psychometric properties of the ACT have been tested since 2006 in acute care, long-term care, and residential settings using different healthcare professionals, including nurses caring for pediatric and adult populations (Estabrooks et al., 2009; Schultz & Kitson, 2010; Squires et al., 2011; Squires et al., 2013; Squires et al., 2014; Squires et al., 2015). Validity assessments of the ACT are considered acceptable based on its use in bivariate associations with the ability to discriminate between care settings using factor analysis and principal component analysis (Estabrooks et al., 2009; Squires et al., 2014). The ACT demonstrated adequate reliability with eight of ten concepts exceeding 0.70 Cronbach's alpha coefficient (Estabrooks et al., 2009; Squires et al., 2014).

Some of the organizational context domains of care based on the ACT can be applied to chemotherapy error prevention. Therefore, the ACT was used in this project to develop a list of potential barriers to both individual and organizational practice change, specifically relating to leadership, culture, human resources, structural resource, electronic resources, and informal and formal interactions or communication. Table A6 identifies the recommended critical practice behaviors and supporting organizational processes within oncology guidelines and practice standards for chemotherapy error prevention, and relates them to appropriate ACT organizational context domains (Neuss et al., 2013; Polovich et al., 2014; Squires et al., 2014).

**Survey content.** Qualitative data was collected through self-reported participant characteristic, practice behavior, and process change responses. Participants were asked to reflect on their practice since course completion. Data demonstrated whether knowledge attained was utilized by different nursing groups who work in various chemotherapy care settings to improve error prevention strategies that adhere to practice guidelines and standards (see Tables A2 and A3). For the purpose of this survey, the definition of chemotherapy included any antineoplastic agent used to treat cancer and administered by the intravenous route. Also for the purpose of this survey, organizational processes were described as policies, procedures, documentation forms, and quality improvement monitoring. Appendix C provides an electronic copy of the survey invitation and content. The survey consisted of seven pages of questions, as described below.

***Survey page one: Participant characteristics.*** The first page of the electronic survey invited respondents to select options that described characteristics of themselves and their practice, with the exception of ethnicity and gender, as these were not supported as in the literature as factors in applying education to practice (See Appendix C), including:

- Age;
- Highest level nursing degree;
- Professional oncology certification(s);
- Years of nursing practice, oncology practice, and chemotherapy care;
- Primary chemotherapy care setting;
- Primary patient population;
- U.S. state of practice; and,
- Month and year of chemotherapy course completion.

***Survey pages two and three: Critical individual nursing behavior change data collection.***

The second and third pages of the survey addressed critical nursing error prevention behaviors. These specific error preventative nursing tasks are components of guidelines and standards presented in the course (Neuss et al., 2013; Polovich et al., 2014). These tasks are performed during the immediate pretreatment and treatment administration phases (See Appendix C).

*Page two: Pretreatment error prevention behaviors.* Respondents were asked to select one of four responses describing their performance of pretreatment critical chemotherapy error prevention behaviors since completing the chemotherapy course. The selections indicated the participants' self-perception of each behavior, selecting whether they: 1) consistently performed the behavior prior to course completion and no change was needed, 2) sometimes or mostly performed the behavior prior to course completion and were now more aware of the need to perform it, 3) did not perform the behavior prior to course completion and have since started performing the behavior, or 4) did not perform the behavior prior to course completion and still do not perform it. The following eleven pretreatment critical chemotherapy error prevention behaviors were evaluated (See Appendix C).

1. Confirm planned treatment education and patient consent for treatment are documented.
2. Review allergies and current list of all medications for potential interactions.
3. Verify and document actual patient height and weight.
4. Ensure and document order completeness by verifying each drug's name, dose, volume, administration route, administration rate, expiration date, and physical appearance.
5. Ensure and document that two chemotherapy competent staff are engaged in chemotherapy order verification process.
6. Use and document only generic drug names.

7. Verify and document dose variations and rationale for each variation.
8. Verify and document any drug-specific cumulative dose and dose limits.
9. Verify and document administration sequence of drugs in regimen.
10. Verify and document correct hazardous drug labeling.
11. Ensure and document that two individuals verify patient identification.

*Page three: Treatment administration error prevention behaviors.* Similarly, respondents were asked to select one of the same four responses describing their performance of the following four treatment administration critical chemotherapy error prevention behaviors (See Appendix C).

1. Utilize infusion pump to eliminate gravity infusions.
2. Use infusion set-up with immediate access to primary flush line and emergency equipment.
3. Assess and document administration site and its appearance.
4. Assess and document treatment tolerance including any immediate effects.

*Survey page four: Supportive organizational process change data collection.* On page four of the survey, participants were asked to select one of five responses describing their perception of three types of organizational policies and procedures after completing the course. The policies and procedures included are general, yet provide systems and unit-based support for the nurses' individual behaviors for chemotherapy error prevention (Neuss et al., 2013; Polovich et al., 2014). The response selections indicate knowledge of the existence of policies and procedures and whether revisions were started or may still be needed (See Appendix C).

1. Policies and procedures that support and detail the steps and components needed in the pretreatment nursing verification process.

2. Policies and procedures that support and detail the steps and components needed in the treatment administration process.
3. Policies and procedures that support and detail nursing pretreatment and treatment administration documentation requirements.

*Survey pages five and six: Barriers to change.* Components of the Alberta Context Tool (ACT) care domains were included in this portion of the survey that assesses for barriers to practice and process change. The list of barriers includes challenges in the context of the chemotherapy care setting that may affect the initiation of practice change, including characteristics, attitudes, and environmental concerns that may indicate concerns related to leadership, culture, human and electronic resources, and interactions or communication (Squires et al., 2014; Weber & Sidorov, 2014) activities.

Respondents selected unlimited responses from a list of potential barriers to individual practice change and organizational change. The selections reflect challenges that may or may not occur when initiating a change related to chemotherapy error prevention. An option to select whether no barriers were encountered was also included.

*Page five: Barriers to individual practice change.* The following themes or concepts are included in the list of nine potential barriers to individual practice change. These were based on the known individual factors contributing to chemotherapy errors (see Figure B1) which include leadership, human, and electronic resources embedded in the ACT contextual care domains (Squires et al., 2014; Weber & Sidorov, 2014) (See Appendix C).

- Awareness of error prevention strategies, policies, and procedures
- Adequacy of course content
- Time constraints

- Reluctance to change or speak up
- Patient engagement in error prevention
- Professional responsibility for error recognition
- Use of computerized records

*Page six: Barriers to organizational policy and procedure change.* The following themes or concepts are included in the list of twelve potential barriers to organizational policy and procedure change. These based on the known system and unit-based factors contributing to chemotherapy errors (see Figure B1) and include leadership, culture, human and electronic resources, and communication/interaction elements within the ACT contextual care domains (Squire et al., 2014; Weber & Sidorov, 2014) (See Appendix C).

- Leadership knowledge, understanding, and receptiveness to change
- Organizational prioritization of error prevention and best practices for error prevention
- Communication issues
- Training and resource issues
- Staffing and time constraints
- Electronic system issues
- Safety culture

*Page seven: Additional information.* An option to complete one open-ended question was provided at the end of the survey. The question asked, “When providing chemotherapy care, please describe what you do differently that helps to identify or prevent chemotherapy errors as a result of the knowledge you have attained and guidelines that were provided in the ONS/ONCC Chemotherapy Certificate course and accompanying e-book?” (See Appendix C). Data obtained in this question will not be analyzed or described in this project.



**Survey Administration Method and Duration**

The survey was administered through the web-based Zarca Interactive program (2015), the established survey program used by ONS. The program allows variability in building a survey and various design formats. Estimated time for completing the survey was verified through a pilot administration sent to six clinical nursing staff employed by ONS who met the same eligibility as actual survey participants. All reported a completion time between eight and nine minutes. Therefore, invitees were told the length of time to complete the survey was estimated to be less than 10 minutes. The survey was open for six weeks, and three reminder emails were sent.

**Rationale for Project Design**

Retention of knowledge related to chemotherapy error prevention strategies was already established by the participants' successful completion of the post-test requirement at the conclusion of the ONS/ONCC course. The project design was selected based on the existing post-program polar (yes-no) evaluation question completed by course participants, in which most indicate they intend to use the knowledge gained to improve their practice. Additionally, error prevention clarification inquiries are often received by the ONS staff, indicating that practice change may be initiated as a result of program content (L. Matey and K. Wiley, personal communication, February 19, 2016). The project design provided an initial step in describing a relationship between the application of knowledge to initiation of practice and process change, with data also used to inform the need for additional educational programming and clinical tool development.

## **Data Collection**

### **Disclosure to Participants**

The survey began with statements identifying the project purpose, survey objectives, expected survey completion time, protection of anonymity during and upon submission of the survey, contact email address, and computer requirements.

### **Data Access and Tools**

The DNP student, ONS preceptor, and faculty advisor had access to the survey data during the 2016 Autumn and 2017 Spring academic semesters. The student and preceptor were involved in data collection. Privacy was assured through the secured ONS database and anonymity of the participant data.

Participants' responses to each survey item were recorded electronically, and summary data was immediately available for review through the Zarca Interactive system. Data was downloaded into an Excel spreadsheet and integrated into the Statistical Package for Social Science (SPSS) (IBM, 2016; Zarca, 2015). A secure cloud-based system was used for immediate storage needs as data was collected and analyzed, which was accessible to the DNP student, preceptor, and faculty advisor.

### **Data Feasibility**

Considerations related to the feasibility of this project included approval by ONS leadership, and was granted prior to its implementation. Technical issues were considered, such as the capability of the survey system, accuracy of email addresses, firewall resistance to receipt of the invitation, and the evaluation and customer databases being fully and readily accessible during the implementation time. Although not needed, the ONS Information Services department

were available to support the project. Additionally, collaboration between the ONS preceptor and the DNP student was ongoing. There was no participation incentive offered by the DNP student.

### **Reliability and Validity**

The survey content was reviewed, piloted, and validated by five oncology clinical specialists who are part of the ONS staff and not involved in course development. Potential errors and problems were addressed that included one typographical error and rephrasing of one variable. The ONS Information Services staff reviewed the survey from a technical standpoint to assure problems related to computer requirements and browser capabilities had been addressed.

### **Data Analysis**

#### **Data Entry and Cleaning**

Data cleaning involved inspecting for missing data with data completeness dependent on the survey response rate and full completion of the survey questionnaire by participants. No surveys were returned incomplete, thus no data were missing. The open-ended question was optional, allowing for further discussion of practice-related change.

Data analysis was performed with SPSS (IBM, 2016). Data analysis included percentages and Fisher's Exact Test to determine relationships between the categorical practice and process change variables, including those based on participant characteristics. Contingency tables were used to prioritize the selected variables identified as potential barriers to practice change. Collapsing of some participant characteristic variables was performed, including age, certification, practice years, and practice settings. A p value of 0.01 was selected due to the large number of tests (more than 100) performed for this project. Fisher's Exact Test was selected since many data cells included fewer than five responses, and some included no responses.

## **Section Four**

### **Findings and Results**

#### **Response Rate**

The project survey invitation (See Appendix C) was sent via email from ONS through the Zarca Interactive system to 5,427 eligible participants. There were 372 (6.9%) undeliverable messages, resulting in 5,095 receiving and 581 (11.4%) opening the invitation. A total of 334 completed the survey, representing a response rate of 6.6%. The number of participants that were ONS members at the time of the project is unknown. ONS typically receives an 8 to 15% response rate for member-based surveys (T. Felice, personal communication, November 10, 2016). The number of participants that were ONS members at the time of the project was unknown. All 50 U.S. states were represented with the five most frequently identified practice states being California, New York, Florida, Illinois, and North Carolina (See Table D1).

#### **Participant Characteristics**

Participant characteristics are detailed in Table D1. There was an equal distribution of course dates in which the participants completed the chemotherapy education program. More than half (55.4%) of the survey participants were baccalaureate prepared nurses. Credentialing with at least one professional oncology certification was reported by 54% of respondents. The majority of respondents had four or more years of oncology nursing experience (64%), including providing chemotherapy care (60%). Almost all respondents (95%) cared for adults with a nearly equal split practicing within inpatient (33.6%) or outpatient (34.2%) oncology settings.

#### **Critical Individual Nursing Behavior Change Results**

Fifteen variables are detailed in Appendix C that list individual error prevention behaviors, eleven of which are recommended to be performed during pretreatment phase, and

four during treatment administration. *Course content was considered impactful on practice if respondents selected they either, 1) sometimes or mostly performed the behavior prior to course completion, and have since become more aware of the need to perform it, or 2) not performed the behavior prior to course completion and have since started performing it.*

**Pretreatment error prevention behavior change.** Two of the eleven pretreatment variables outranked the others for having the highest perceived impact on practice (See Table D2). These were, 1) verification and documentation of drug-specific cumulative dose or dose limits (27%), and 2) use and documentation of only generic drug names (23%). Other pretreatment variables perceived as having impact on practice behavior included verification and documentation of dose variations (16%), as well as verification of the correct administration sequence of drugs within each regimen (11%). About 10% of respondents reported a higher awareness to verify and document actual patient height and weight, along with correct hazardous drug labeling (See Table D2).

**Treatment administration error prevention behavior change.** The majority of respondents endorsed frequent participation in the four treatment administration variables (See Table D3). The small subset of respondents who engaged in behavior change indicated utilization of an infusion set-up with immediate access to primary flush line and emergency equipment was improved (10%).

### **Significant Findings in Critical Individual Nursing Behavior Change Results**

Results that were statistically significant ( $p \leq 0.01$ ) based on participant characteristics are depicted in Tables D7 and D8. Overall, the most significant differences in course content impacting practice was reported between certified and non-certified nurses, with some significance noted between inpatient and outpatient nurses.

**Certified versus non-certified nurses.** All respondents reporting one or more professional oncology certifications were considered certified nurses. Statistical significance was found in nine of the 15 total individual nursing behavior error prevention variables. Non-certified nurses reported the course content had an impact on practice more than certified nurses, and certified nurses correspondingly indicated more frequently that their practice did not need to change because they already performed the behaviors prior to taking the course.

***Pretreatment error prevention variables.*** Verifying and documenting drug-specific cumulative dose or dose limits showed the largest difference based on participants' certification credentials, with 18% of certified nurses versus 38% of non-certified nurses reporting this behavior was impacted by course content ( $p=0.001$ ). More non-certified nurses reported being more aware of the need to perform, or having started to perform, three of the pretreatment practice behaviors, including verification and documentation of: 1) actual patient height and weight ( $p=0.005$ ), 2) allergies and current medication list ( $p<0.001$ ), and, 3) patient education and consent for treatment ( $p=0.010$ ). More non-certified than certified nurses reported having increased awareness or performance of the verification and documentation of specific order components ( $p=0.005$ ) and correct hazardous drug labeling ( $p=0.004$ ). Higher awareness of, or practice change that includes, ensuring two individuals verify and document patient identification was reported by more non-certified than certified nurses ( $p<0.001$ ) (See Table D7).

***Treatment administration error prevention variables.*** The two treatment administration behaviors with statistically significant differences between non-certified and certified nurses were assessment and documentation of: 1) administration site appearance ( $p=0.002$ ), and 2) treatment tolerance including any immediate effects ( $p=0.009$ ).

**Inpatient versus outpatient nurses.** One pretreatment and one treatment administration variable demonstrated a statistically significant comparison among nurses providing chemotherapy care in inpatient and outpatient settings (See Table D8). Statistical significance was associated with a clustering of reported care settings, where inpatient nurses represented those working in inpatient oncology along with inpatient non-oncology, intensive care, and BMT units. Outpatient nurses included those caring for patients in outpatient oncology clinics and infusion centers. Inpatient nurses reported more awareness of the need to perform, or have started performing: 1) verification and documentation of drug-specific cumulative dose or dose limits ( $p=0.004$ ), and 2) use of an infusion set-up with immediate access to a primary flush line and emergency equipment ( $p=0.002$ ).

### **Significant Findings in Organizational Process Change Results**

Three questions asked survey participants whether organizational process change was initiated since taking the course (See Appendix C). Nearly half of all respondents noted that error prevention policies and procedures were already in place without a need for change. The majority of the remaining respondents reported initiating conversations with peers and nursing leaders to review or revise policies and procedures for pretreatment error prevention (39%), treatment administration (37%), and nursing documentation (30%) (See Table D4).

### **Significant Findings in Barriers to Change Results**

Survey participants selected one or more statements that reflected their perception of barriers encountered or anticipated when initiating individual behavior change and change to organizational policies and procedures.

**Barriers to individual practice change.** Participants selected one or more statements that reflected challenges to change in their personal practice (See Table D5). Almost 40% of

participants reported no barriers to their personal practice change. The most frequently cited challenge was finding effective strategies to engage patients in error prevention practices (31.7%). This was followed by designation of responsibility for order verification (18%), resistance to change by nursing colleagues (16.5%), and lack of time to make changes (12%) (See Table D5).

**Barriers to organizational policy and procedure change.** As with individual practice change barriers, nearly the same percentage (40%) of participants selected one or more challenges to initiating change to organizational error prevention policies and procedures, including documentation forms and quality improvement monitoring (see Table D6). The most frequently cited organizational barriers included inadequate staffing and time constraints (30.5%), electronic systems that are difficult to change (21%), and lack of ongoing education and monitoring related to error prevention (17.7%), policies and procedures not reflecting best practices (16.2%), ineffective interprofessional communication (15%), and lack of understanding and knowledge of error prevention by organizational leaders (about 15%) (See Table D6).

**Age of nurses.** Responses from different age groups of nurses is most notable in perception of barriers to individual practice change ( $p=0.001$ ) and organizational policy and procedure change ( $p=0.005$ ). For the most part, an inverse correlation was found, showing percentages of those perceiving barriers decreasing as age increases (See Table D9).

**Practice years of nurses.** An inverse correlation between practice years and perceived barriers to both individual ( $p=0.005$ ) and organizational ( $p=0.005$ ) practice was found. As practice years increased, the identification of barriers decreased (See Table D9).



## Discussion

Several results and findings from this project are notable, and are presented here with considerations for interpretation. Regardless of participant characteristics and groupings of nurses, the impact of the course on individual error prevention practice behaviors varied greatly depending on the specific task being addressed in each survey question. Course content had an inconsistent impact on critical individual nursing behaviors during the pretreatment and treatment administration. Up to 27% of respondents reported either increased awareness of the need to perform a specific behavior, or that they had started to perform a specific behavior since taking the course (See Tables D2 and D3). Considerations important to note at the individual and systems levels may contribute to the risk for chemotherapy errors as depicted in Figure B1 (ASCO, 2016; AHRQ, 2016; ASHP, 2015; CCO, 2012; CCO, 2014; Farag et al., 2016; Fyhr et al., 2015; Hung et al., 2016; IHI, 2012; IOM, 1999a; IOM, 2013; ISMP, 2016; Keers et al., 2013; Kloth, 2010; Lennes et al., 2016; Nelson et al., 2014; Neuss et al., 2013; Neuss et al., 2016; Polovich, 2015; Polovich, et al., 2014; Schulmeister, 2006; Schulmeister, 2008; Schwappach & Wernli, 2011; Walsh et al., 2009; Warren, 2014; Weber & Sidorov, 2014).

Impact of the course on individual practice change was noted in both pretreatment and treatment administration behaviors. The increased awareness or initiation of four behaviors (i.e. verification and documentation of: 1) drug-specific cumulative dose and dose limits, 2) dose variations and their rationale, 3) the sequence of the agents in the regimen, and 4) the use of only generic drug names) after the educational program may suggest systems-based issues related to the context of care, such as unit-based training, resource availability, and competency evaluation processes. Additionally, individual factors to consider include the level of error prevention knowledge, self-confidence, and vigilance toward verifying order details to prevent errors (See

Figure B1). Treatment administration behaviors may be influenced by external sources rather than an individual nurse's motivation to change. First, the use of an infusion pump and set-up that assures access to a primary flush and emergency equipment may vary based on the types of treatments being administered in each care setting (intravenous push versus intermittent or continuous infusion), and the availability and functionality of infusion equipment (smart versus non-smart pump). Secondly, although assessment and documentation of the administration site and immediate effects of treatment are behaviors that demonstrate attention to the cyclical nursing process and adherence to recommended error prevention strategies, performing these behaviors may not be an organizational expectation that is clearly supported by organizational policies, procedures, and documentation systems.

The significant findings related to certified and non-certified nurses were unexpected. While certification was not specifically included in the exhaustive literature search methods, critical appraisal of the evidence did not identify the attainment of professional certification as a strategy or best practice to prevent medication or chemotherapy errors, or as potentially impacting practice change following an educational intervention. Of importance to note because it has been highlighted in other results, is that the behavior impacted most by the course content for both certified (18%) and non-certified nurses (38%) was the need to verify and document drug-specific cumulative dose and dose limits during the pretreatment phase. However, non-certified nurses consistently reported course content had a higher impact on eight other practice behaviors than certified nurses, stating course content made them more aware of the need to perform, or that they had changed practice and started performing the behaviors (See Table D7). Assumptions as to why fewer certified nurses perceived more awareness of, or the need to change a behavior, than non-certified nurses may be age and experience, as certification

eligibility is partially based on practice experience. Also, certified nurses may have completed more oncology-specific education during their certification preparation, providing them with a stronger foundation of knowledge related to error prevention. Lastly, a question to consider is if higher self-confidence among certified nurses may result in the perception that practice change was not needed as often as with non-certified nurses.

The need to verify and document drug-specific cumulative doses and dose limits during the pretreatment phase was cited by a subset of nurses regardless of certification status. However, this was a significant notation among the inpatient and outpatient nursing groups. Inpatient nurses reported course content gave them a higher awareness of the need to perform, or that they started to perform this behavior more frequently than outpatient nurses (See Table D8). Although interesting, this may be a logical difference considering the literature recognizes the need for effective communication, coordination of care, and integration of electronic systems to be in place to accurately translate treatment protocols and summaries between various care settings (Brady et al., 2009; Farag et al., 2017; Fyhr et al., 2015; Harris & Northfelt, 2005; Hung et al., 2016; McNab et al., 2016; Markert et al., 2009; Nelson et al., 2014; Schwappach & Gehring, 2015; Walsh et al., 2013). Having a primary flush line and emergency equipment readily available during treatment administration also demonstrated a higher awareness or need for change among inpatient nurses. As stated previously, this may correspond to the types of treatments being administered, along with varying infusion and emergency equipment availability between settings.

Two project outcomes deserve meaningful consideration, although not statistically significant. Overall, a high percentage of responses indicated no perceived need to change because specific behaviors were already being performed (See Tables D2 and D3). More than

70% of respondents reported this for eight of the eleven pretreatment behaviors, and more than 75% reported already performing the four treatment administration behaviors. This suggests many individual nurses were already knowledgeable about error prevention strategies and apply them to daily practice. Conversely, a subset of respondents indicated they did not perform specific behaviors prior to or upon completion of the course (See Tables D2 and D3). As such, this may be an area which course developers review to enhance future course content.

Barriers to initiating practice change are crucial to note at this point, and may affect perceived impact of the course content (Melnik, 2012; Melnik & Fineout-Overholt, 2015; Melnik, Fineout-Overholt, Gallagher-Ford, & Stillwell, 2011; Melnik et al., 2017; Squires et al., 2014). More than 60% of participants reported encountering or anticipating at least one challenge when initiating change in their own practice (See Table D5). This may suggest the practice implementation barrier prevented change from being reported in the survey, so the nurse reported more awareness of the need to perform a behavior because of the challenge. Patient engagement in error prevention was ranked as the biggest challenge, correlating with some of the literature review citing the need to assure patients are partners in safety, as well as the newly established reporting requirements that demonstrate patient-centric care is being delivered (Etchegaray et al., 2016; Harris et al., 2014; Kullberg et al., 2013; Nelson et al., 2014; Schulmeister, 2008; Schwappach et al., 2010; Schwappach & Wernli, 2011; Shojania et al., 2001).

Professional accountability of the nurse may be a concern, as it was the second highest ranked barrier with some nurses believing the physician and pharmacist are primarily responsible for error prevention. The third highest barrier was that nurse colleagues may question the necessity of practice change recommendations based on course content. The latter may relate to the need for personal empowerment among younger or less experienced nurses, with evidence

suggesting that errors are affected by practice experience and incivility issues among nursing peers (AHRQ, 2016; Fyhr et al., 2015; Harris & Northfelt, 2005; Hung et al., 2016; McNab et al., 2016). Lastly, time constraints as a barrier to individual practice change is supported in the literature, and may reflect ineffective personal time management or workload and staffing ((Harris & Northfelt, 2005; Prakash et al., 2014; Trbovich et al., 2010; Walsh et al., 2013).

At least 30% of respondents reported starting discussions at their institutions upon recognizing the need to review or revise organizational error prevention policies and procedures based on course content (See Table D4). While this outcome may indicate the course content had an impact on organizational change, it also suggests a priority patient safety through practice change was demonstrated by one-third of the individual nurse participants who initiated the conversations. Policies and procedures as drivers to support error prevention through recommended pretreatment and treatment administration behaviors were most frequently addressed in these conversations with nursing peers, managers, and leaders.

Barriers to organizational change are key project outcomes to consider. Again, more than 60% of participants reported at least one challenge was encountered or anticipated in initiating change at the organizational level. Time and staffing were selected as the most identified barrier, and are noted as clear prohibitive factors to the change process within the literature (AHRQ, 2016; Farag et al., 2016; Fyhr et al., 2015; Hung et al., 2016; IHI, 2012; IOM, 2013; Keers et al., 2013; Lennes et al., 2016; Nelson et al., 2014; Polovich, 2015; Schulmeister, 2008; Schwappach & Wernli, 2011; Walsh et al., 2009). Also supported in the literature is the need for electronic systems that are easily adaptable, and electronic systems being difficult to change were the second highest ranking barrier to organizational change (Bourmaud et al., 2014; Cheng et al., 2012; Dobish et al., 2016; Gandhi et al., 2005; ISMP, 2016; Jia et al., 2016; Kullberg, et al.,

2013; Nerich, et al., 2010; Rodriguez, 2016; Ranchon et al. 2011; Walsh et al., 2013; Watts & Parsons, 2013; Weingart et al., 2010). Organizational culture is the theme in the remainder of the most selected barriers, including lack of ongoing training and monitoring for errors, policies and procedures that do not support best practices in error prevention, poor interprofessional communication, and lack of leaders' understanding and knowledge of error prevention.

### **Conclusions**

The prevention of chemotherapy errors and provision of comprehensive chemotherapy education are recognized priorities in cancer care settings. The purpose of this project was to assess the impact of knowledge attained from a comprehensive chemotherapy course on individual nursing behaviors and organizational processes that are compliant with evidence-based chemotherapy error prevention strategies. This program evaluation was an initial step in describing a correlation between the application of knowledge to practice through behaviors that promote chemotherapy error prevention.

### **Overall Survey Themes**

Conclusions are presented as they relate to the three overall survey themes (See Section Three). The project survey content covered three themes that explored nurse participants' post-program perceptions relating to error prevention and considered the need for, initiation of, and barriers to individual and organizational change (See page 30 and Table A5). Certified nurses were less likely to perceive a need for practice change than non-certified nurses. Regardless of age, practice experience, work setting, or certification, the two critical individual nursing behaviors most significantly impacted overall by course content were verifying and documenting drug-specific dose limits and cumulative doses, and the use and documentation of only generic drug names (See Tables D2 and D3). The course also had an impact on organizational process

change, with more than one-third of the respondents initiating conversations with nursing peers and leaders to improve organizational error prevention processes, specifically policies and procedures that support their individual behaviors (See Table D4).

Respondents encountered or anticipated challenges to individual practice change and organizational process change that correspond to the literature and recent trends in the oncology environment. The most notable barriers to individual practice change were needing better patient engagement in error prevention, lack of professional accountability for preventing errors, and potential nursing incivility. Challenges to initiating organizational process change primarily indicate underlying factors associated with system structures and unit level context of care, such as ineffective leadership, failure to prioritize safety goals and processes, inadequate resources, and poor communication (See Tables D7 and D8).

## **Section Five**

### **Project Summary**

This project assessed how the ONS/ONCC Chemotherapy and Biotherapy Certificate course may impact individual and organizational practice specific to error prevention strategies. An observational design methodology guided the project consisting of a descriptive cross-sectional survey that utilized retrospective, self-reported data obtained from 334 registered nurses through a web-based questionnaire. Survey content was developed based on 15 recommended individual critical behaviors and their supporting organizational processes for chemotherapy error prevention interspersed in practice guidelines and standards. The survey content covered three themes that explored nurse participants' post-program perceptions of the need for, initiation of, and barriers to individual and organizational change for error prevention. Impact on practice was considered to have occurred if course participants developed more awareness of the need to perform specific behaviors, or changed practice to better integrate error prevention strategies at the individual and organizational levels. This program evaluation was an initial step in describing a correlation between the application of knowledge to practice through behaviors that promote chemotherapy error prevention.

### **Limitations**

Limitations of this project include the low survey response rate of 6.6%. ONS typically receives a response rate between 8 and 15% for member-based surveys. The lower response rate may be attributed to the fact that less than half of registered participants in the ONS/ONCC Chemotherapy and Biotherapy Certificate course were ONS members. Non-members may not be accustomed to receiving ONS emails or may not consider opening emails received from ONS compared to members. The survey was also conducted in the six weeks prior to the Thanksgiving



and December holiday season, therefore competing with many life events. Another limitation relates to practice characteristics, with almost all respondents providing chemotherapy care to adults and only 6% working in a BMT setting. Nurses in pediatric hematology/oncology and BMT settings administer antineoplastic agents quite frequently. Therefore, this sample may not adequately represent all nurses delivering chemotherapy care.

Lastly, this project collected retrospective, self-reported data and asked participants to reflect on how course content impacted practice in the six to twelve months since completing the course. Recall problems and response bias may occur in survey participants. These may be due to the length of time since the course was completed, and if the nurse reports more or less behavior change than actually occurred (Stommel & Wills, 2004).

### **Implications for Practice**

The outcomes of this project assist in understanding the educational and supportive needs of nurses who provide chemotherapy care, specifically related to implementing error preventive strategies into practice behaviors, policies, and procedures. The data analysis outcomes were integrated into the three project survey themes in Section Four, and support the EBP process described in the ARCC Model through the five evidence-based recommendations for practice change presented in Section Three. Additionally, this project demonstrates alignment with the Doctor of Nursing Practice (DNP) Essentials (AACN, 2006).

### **Recommendations for Practice Change**

#### **Recommendation One: Provide comprehensive chemotherapy education for nurses.**

This project assessed just one area of content interspersed throughout the ONS/ONCC Chemotherapy and Biotherapy Certificate course. Project outcomes describe the impact of educational content on error prevention at both the individual and organizational levels, and

ongoing education and competency assessments are considered best practices in error prevention. Certification preparation resources may enhance the performance of critical nursing behaviors for error prevention. Barriers to implementing safety practices may need more attention within the course. Collaboratively reviewing course content with error prevention and EBP subject matter experts may strengthen the program with inclusion of professional practice strategies for implementing behaviors and overcoming barriers to change.

**Recommendation Two: Integrate practice guidelines and standards.** Evidence-based error prevention practices included in the ONS/ONCC course content are grounded in guidelines and standards that address both individual practice behaviors and organizational processes. However, the 15 critical individual nursing behaviors identified and used in this project were not found in one cohesive grouping, but rather fragmentally identified within guidelines, standards, and the content of the course. Project outcomes suggest that while the critical best practices are widely available, they are not always included in policies and procedures or may be missing completely. Rethinking the presentation and dissemination of best practices for error prevention, and utilizing EBP champions to assess readiness for change through review of policies and procedures, and further exploration of barriers to implementation may be a beneficial approach.

**Recommendation Three: Assess practice change needs related to critical behaviors.** Project outcomes propose that most nurses are already practicing all except two of the critical individual behaviors; however, all 15 recommended behaviors should be implemented to optimize patient safety and demonstrate accountability for error prevention. The presence of barriers to practice change reported by 60% of respondents suggests nurses may benefit from strategies to enhance personal and professional empowerment. A strong interprofessional statement or report of the need to include the 15 behaviors in practice may reinforce their

integration into practice. This statement or report, along with a better organized presentation and dissemination of recommended critical individual nursing behaviors may assist EBP champions to more effectively demonstrate a change is needed.

**Recommendation Four: Implement organizational processes to support practice change.** Practice change adoption in individuals may not correspond to readiness to change within the workplace culture and context of care. Project outcomes indicate more than 30% of respondents identified a need to initiate review or revision of organizational error prevention policies and procedures. And, more than 60% of participants encountered or anticipated at least one barrier to making those organizational changes. Again, a strong interprofessional statement or report may help EBP champions to elevate organizational understanding of the connection between effective implementation of evidence-based error prevention strategies and improved patient outcomes.

**Recommendation Five: Prioritize a culture of safety.** The intent to list the recommendation to prioritize safety late is purposeful. This recommendation is, by far, the most important because it provides the foundation for effective chemotherapy error prevention. Project outcomes describe a need for champions to advocate for a safe and just culture, with 60% of survey respondents identifying one or more barriers to implementing a change that is aimed at preventing chemotherapy errors and improving patient safety outcomes. Without a true culture of safety, the 15 critical individual error preventive nursing behaviors cannot be fully supported or effectively implemented, even if strong organizational processes, policies, and procedures exist. A culture of safety involves a commitment to prioritizing safety goals over all else. This includes error prevention, recognition, and reporting that transcends through all levels and is demonstrated within all disciplines.

The results also help to determine the effectiveness of current chemotherapy programming, enhance future offerings, develop tools to assist with guideline and EBP implementation processes, and establish ongoing practice change data collection to further impact the quality of chemotherapy care.

### **Alignment with the Doctor of Nursing Practice Essentials**

The Essentials of Doctoral Education for Advanced Practice Nursing (AACN, 2006) provide guidance for Doctor of Nursing Practice (DNP) program curriculum, and delineate the competencies of a nurse holding the DNP credential. The eight DNP Essentials are integrated and demonstrated in the final DNP scholarly project (Moran, Burson, & Conrad, 2014). “Rather than a knowledge-generating research effort, the student in a practice-focused program generally carries out a practice application-oriented final DNP project” (AACN, 2006, p. 3). This DNP project demonstrates practice scholarship by exploring a clinical practice problem, and guiding the translation of evidence-based knowledge into practice for improved patient safety (AACN, 2015; Moran et al., 2014). This project aligns with the DNP Essentials as described below.

#### **DNP Essential I: Scientific Underpinnings for Practice**

DNP Essential I addresses the use of evidence-based literature and theories, models, or frameworks aimed to improve practice outcomes. These supporting elements demonstrate whether an intervention may correlate with changes that promote implementing evidence-based care and decision-making (AACN, 2015; Moran et al., 2014). Relating Essential I to this project, medication errors may have significant impact on care delivery; interventions to reduce errors and continually evaluate outcomes are grounded in evidence-based guidelines and standards (AACN, 2006, p. 9). This project assesses nurses’ perception of practice change specific to error prevention following educational programming. The survey content reflects evidence-based

strategies found within practice guidelines and standards, and presented in a comprehensive chemotherapy course. Additionally, the use of two science-based frameworks and a model for implementing evidence into practice guided development of the survey content of this project.

### **DNP Essential II: Organizational and Systems Leadership for Quality Improvement and Systems Thinking**

DNP Essential II implies the ability to collaboratively identify and address emerging practice problems to improve the quality of care at all levels within the organization (AACN, 2015; Moran et al., 2014). Specific to this project, a critical safety need for a specific patient population is identified and the impact of one evidence-based intervention for improvement is deeply explored (AACN, 2006, p. 10). This project explores chemotherapy errors as a multifactorial variance and quality improvement priority with interdisciplinary accountability. Sustainable structural and unit-based processes as well as individual behaviors that address error recognition and reporting are explained and integrated throughout the project. This project particularly describes perceptions and challenges faced by nurses that may impact practice change and patient safety through error prevention.

### **DNP Essential III: Clinical Scholarship and Analytical Methods for Evidence-Based Practice**

DNP Essential III refers to the application critical analysis and thinking processes. Best practices are determined by critically appraising the existing evidence. In addition, evaluating programs and processes to assess their impact on practice is key to Essential III (AACN, 2006, p. 12; AACN, 2015). Specific to this project, determining the impact of chemotherapy education on nursing practice to prevent errors is the goal. Existing educational processes and content, practice guidelines and standards, and evidence from various studies are appraised and applied

within the project. More specifically, this project seeks to know the impact of education on the application of critical behaviors supporting processes within the practice environment.

#### **DNP Essential IV: Information Systems/Technology and Patient Care Technology for the Improvement and Transformation of Health Care**

DNP Essential IV relates to the application of information systems and technology to evaluate care outcomes (AACN, 2006, p. 12; AACN, 2015). This project aligns with Essential IV in multiple ways. Firstly, this project uses a web-based survey to assess the impact of a chemotherapy education program delivered through an online learning management system. Secondly, strategies for error prevention are explored that include electronic and computerized ordering and documentation, decision supports, and smart infusion pumps. Thirdly, variables within the project survey include the use of appropriate patient care equipment and infusion set-ups that are components of recommended chemotherapy error prevention strategies. Lastly, this project encompasses potential barriers related to the use of technology that can facilitate the understanding of the nurse's role in error recognition to improve outcomes.

#### **DNP Essential V: Health Care Policy for Advocacy in Health Care**

DNP Essential V addresses advocating for healthcare policy, including structures and processes that guide professional standards development and institutional decision making (AACN, 2006, p. 14; AACN, 2015; Moran et al., 2014). Safety training, the use of evidence-based knowledge, and outcome reporting are integral parts of professional practice standards, as well as regulatory accreditation agencies, reimbursement stipulations, and health policy legislative criteria. The failure to prevent errors leads to ethical dilemmas that weaken confidence in clinical judgment, increase risk for harm, and erode patient-provider trust. This project identifies a critical safety issue in the oncology environment, critically analyzing

standards related to mitigating the risk of chemotherapy errors. The project advocates for patients, nurses, and organizational leaders by exploring best practices for error prevention and conducting a program evaluation that assesses the impact of education on practice change.

### **DNP Essential VI: Interprofessional Collaboration for Improving Patient and Population Health Outcomes**

DNP Essential VI addresses effective communication and collaboration among various disciplines (AACN, 2015; Moran et al., 2014). Specific to medication errors, a collaborative, multidisciplinary systems approach is essential to develop a culture that cultivates practice excellence and prioritizes safety. The need for establishing interprofessional and individual accountability in error prevention is stated throughout the stages of this project. This project describes the complexities involved in the chemotherapy planning and administration process from an interprofessional standpoint, while focusing on the potential impact of education as an error prevention strategy.

### **DNP Essential VII: Clinical Prevention and Population Health for Improving the Nation's Health**

DNP Essential VII delineates the need for clinical prevention through health promotion and risk reduction. This may involve a deep look into a specific aggregate population, such as people with cancer who are receiving antineoplastic agents (AACN, 2006, pp. 14-15; AACN, 2015). Due to the hazardous nature of many of these drugs and the common presence of comorbid conditions, overdosing and underdosing may result in patient harm. Specific to this project, data is analyzed that include the implementation and evaluation of interventions to improve outcomes through error prevention. This project seeks to improve the health of a

specific patient population through error prevention, and explores the integration of, and barriers to, applying education to nursing practice and organizational policies and procedures.

### **DNP Essential VIII: Advanced Nursing Practice**

DNP Essential VIII addresses the highest level of nursing practice through expertise, advanced knowledge, and specialization. This competency emphasizes the demonstration of clinical judgment and accountability, including the design, implementation, and evaluation of interventions based on critical appraisal of all levels of evidence that support the nursing profession and facilitate optimal practice outcomes (AACN, 2006, pp. 16-17; AACN, 2015). This project shows alignment with Essential VIII by evaluating the impact of an educational program that teaches foundational safety practices and error preventive strategies. The clinical problem of chemotherapy errors necessitates that educational needs of nurses are met with knowledge that is easily translated into practice. Chemotherapy nurses must possess the skills and confidence to provide care that optimizes patient and staff safety. Additionally, organizational processes and clinical tools need to be sufficient to support the integration of error prevention strategies into practice. This project seeks to identify individual and organizational change impacted by the integration of knowledge to practice, and barriers to initiating change. This project makes a connection between practice, organizational, accreditation, and policy issues related to medication errors specific to the oncology environment.

### **Project Dissemination**

Dissemination of the outcomes of this project are of interest to a variety of nursing leaders, patient safety professionals and advocates, professional oncology associations, and QI and EBP professionals.



**Potential Audiences**

Executive leaders, clinical nurse leaders and managers, staff educators, and clinical nurse specialists may find the outcomes relate to their patient safety goals, and can be utilized to review and potentially improve error prevention strategies within practice settings where chemotherapy care is delivered to assure best practices are implemented. The same executive and clinical leaders may want to assess the safety culture of their environments to better prioritize pharmacovigilance and safety related to high-risk medication ordering and administration.

Organizations with an interest in attaining or maintaining Magnet recognition status, as well as nurse credentialing agencies, such as ONCC and the American Nurses Credentialing Center (ANCC), may be curious to learn about the practice change data differences between certified and non-certified nurses. Professional oncology associations, such as ASCO, ONS, and the Advanced Practitioner Society for Hematology and Oncology (APSHO) may be interested in learning how nurses utilize error prevention strategies in practice that are based on accepted practice guidelines and standards. These same professional organizations can utilize the findings to promote and improve chemotherapy education for nurses and other healthcare professionals. Lastly, health policy and regulatory agencies interested in patient safety outcomes may recognize the importance of practice change and error prevention implementation strategies.

**Methods of Dissemination**

The project background, purpose, description, and outcomes have been submitted and accepted at two professional nursing conferences as poster presentations in May, 2017. A third abstract has been submitted for possible presentation at an EBP conference in October, 2017. A manuscript is being prepared to submit for publication in a peer-reviewed oncology journal by June, 2017. Additionally, some data collected through the survey is not considered central to the

topic or project purpose. Further analysis of this supplemental data will be performed, with possible submission for publication later in 2017.

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Footnotes

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<sup>2</sup> Used with permission. Graham et al., 2006.

<sup>3</sup> *Used with permission.* © Melnyk & Fineout-Overholt, 2005.



## Appendix A: Evidence and Descriptive Tables

## Tables A1, A2, A3, A4, A5, A6

Table 1

*Synthesis of Studies to Determine the Incidence of Chemotherapy Errors*

<b>Citation</b>	<b>Type of Study</b>	<b>Percent (%) Incidence of Chemotherapy</b>
Gandhi et al., 2005	Prospective cohort study	3.0% (n = 10,112)
Ford et al., 2006	Prospective study	0.04% (n = 4680)
	Retrospective record review following prospective study	0.02% (n = 200)
Markert, et al., 2009	Prospective descriptive study	3.8% - 4.5% (n = 22,216)
Ranchon et al., 2011	Prospective study	5.2% (n = 6,607)

*Note.* Percent incidence of chemotherapy errors based on number of orders reviewed.  
n = number of chemotherapy orders reviewed

Table 2

*Evaluation and Synthesis of Reports, Standards, and Guidelines Related to Medication and Chemotherapy Errors*

<b>Citation and/or Expert Committee</b>	<b>Design and/or Methods</b>	<b>Topic of Interest or Clinical Problem</b>	<b>Data Analysis</b>	<b>Findings and Recommendations</b>	<b>Level and Quality of Evidence</b>
IOM, 1999a	Expert report; systematic review	Quality cancer care	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 1999b	Expert report; systematic review	Medical errors	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 2001	Expert report; systematic review	Healthcare quality	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
Shojania et al., 2001	Expert report; systematic review	Healthcare safety	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 2003	Expert report; systematic review	Patient safety; nursing work environment	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 2004	Expert report; systematic review	Patient safety standards	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 2006	Expert report; systematic review	Preventing medical errors	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
Kloth, 2010	CPG; systematic review	Preventing chemotherapy errors	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IHI, 2012	CPG; systematic review	Preventing harm from high- alert medications	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
CCO, 2012	CPG; systematic review	Safe chemotherapy administration; part 1	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
IOM, 2013	Expert report; systematic review	Quality cancer care; follow up to IOM, 1999a	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
Shekelle et al., 2013	Expert report; systematic review	Healthcare safety; follow up to Shojania et al., 2012	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
Neuss et al., 2013	Practice standard; systematic review	Chemotherapy administration safety standards	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention

<b>Citation and/or Expert Committee</b>	<b>Design and/or Methods</b>	<b>Topic of Interest or Clinical Problem</b>	<b>Data Analysis</b>	<b>Findings and Recommendations</b>	<b>Level and Quality of Evidence</b>
CCO, 2014	CPG; systematic review	Safe chemotherapy administration; part 2	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
ASCO, 2016	CPG; systematic review	State of cancer care	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
Polovich et al., 2014	Guidelines; systematic review	Chemotherapy guidelines and recommendations	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention
ASHP, 2015	CPG; systematic review	Preventing chemotherapy errors	Synthesis of evidence; expert consensus	Tables A4 and 5; Figure B4	1; high; significant evidence supporting recommendations for error prevention

*Note.* Publications are listed chronologically to show progression of attention to the clinical issue. Levels of evidence for CPGs and reports are based on the rating system for the hierarchy of evidence for intervention/treatment questions (Melnik & Fineout-Overholt, 2015, p. 11). Additional considerations for the quality of evidence for CPGs are based on the IOM eight standards for developing trustworthy guidelines (IOM, 2011).

Table 3

*Evaluation and Synthesis of Additional Supporting Literature Related to Medication and Chemotherapy Errors*

<b>Citation</b>	<b>Theoretical Framework</b>	<b>Design and/or Methods</b>	<b>Sample and Setting</b>	<b>Aim and Major Variables Studied</b>	<b>Outcomes Measured or Discussed</b>	<b>Data Analysis</b>	<b>Findings and Recommendations</b>	<b>Level and Quality of Evidence</b>
Keers et al., 2013	Reason's model of accident causation	Systematic review	54 studies with data on inpatient medication errors; chart review and direct observation	Determine causation factors for medication administration error and near miss data	Perceived responsibility for medication preparation and dispensing errors	Percentages	-Individual causes for error related to knowledge and rule based mistakes: 53.7%; -Environmental and structural conditions including policies and procedures: 31.7%	5; moderate to high; supports known contributors to error
Brady et al., 2009	Human error models	Systematic review	26 peer-reviewed qualitative and quantitative studies	Determine contributing factors to medication errors	-Knowledge, skill, level, workload, distractions of nurses -Processes for drug dispensing and error reporting	No stats	-Findings: Most common contributor to errors: nurse drug knowledge, dispensing process, quality of orders; deviation from standard dosing; nurse distraction; excessive workload -Recommendations: Assurance of consistency of error reporting; ongoing competency assessment for nurses; standardize error reporting process through healthcare policy initiation, local outcomes evaluation	5; moderate to high; supports known contributors to error and resulting strategies for error recognition, reporting, and reduction
Smeulders et al., 2015	None	Systematic review; PRISMA	5 qualitative studies	Assess specific structure, process, and outcome quality indicators pertaining to safe medication use	21 quality indicators for medication management	Quality indicator sets; AIRE instrument tool	-Recommendations: Further development of quality indicators addressing nursing, specific to patient identification, route verification, appropriate documentation	5; moderate to high; quality indicators to support strategies for error recognition, reporting, and reduction

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
Weingart et al., 2010	None	Systematic review including disparate database review	508 reported oral chemotherapy events	Determine types of chemotherapy errors	-Type of error -Phase in medication use process of error occurrence	Interrater reliability; percentages	-Findings: Similar types and phases of error occurrence as with other types of chemotherapy -Recommendations: Standardize oral treatment ordering and monitoring processes	5; moderate to high; supports known contributors to error and resulting strategies for error reporting and reduction
Kullberg et al., 2013	None	Literature review; descriptive and qualitative studies	12 studies reviewed	Explore interventions to reduce chemotherapy errors	Consistency of five specific interventions in reducing error	No stats	-Findings: CPOE consistently safer than handwritten orders; other interventions helped to improve patient safety -Recommendation: More studies about using FMEA, error reporting systems, administration checklist, nursing education	5; moderate; good composite of literature review; background information on specific documentation; supports strategies for error recognition, reporting, and reduction
Schwappach & Wernli, 2010	None	Literature review	112 studies	Explore patient willingness to be involved in error prevention activities	Strategies to engage patients in error prevention	No stats	-Recommendations: Ongoing motivation and reiteration of importance of patient engagement; use simple rule-based instructions; perform verification together; explain device alarms; ongoing teaching; continuous request of patient status info	5; moderate to high; supports strategies for error recognition, reporting, and reduction
Baldwin & Rodriguez, 2016	None	Retrospective, descriptive study; RISQ database	4,282 events; error database inquiry; 5 years	Describe importance of chemotherapy verification nurse in identifying prescribing errors	Roles of verification nurse	No stats; percentages and anecdotal data	-Findings: 506 of 4282 events occurred after verification nurse involvement (0.07%), most during administration causing no patient harm; majority near-miss events, induced no patient harm, or	5; moderate; no stats reported on errors before verification nurse involvement; supports important standards

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
Markert et al., 2009	None	Prospective cohort study	22,216 chemotherapy orders; inpatient and outpatient oncology; 2 years	Assess the effectiveness of a chemotherapy surveillance team in preventing medication errors	Number and types of chemotherapy errors; error interception rate	No stats; percentages reported	identified at the point of prescribing -Recommendation: Value of verification nurse is high with comprehensive review of order for completeness, accuracy/appropriateness -Findings: 3,792 errors in 22,216 orders, most administrative; 3 errors reaching the patient for 99.9% error interception rate -Recommendation: Consider use of multiple check interprofessional chemotherapy order surveillance team	inclusion of strategy for error recognition and reduction 6; moderate; supports strategy for error recognition
Robinson, et al., 2006	FMEA	Prospective QI study; preimplementation and 12 months postimplementation	331 records pre and 221 medical records post; hospitalized children with cancer; acute care	Determine error prevention and reporting behaviors pre and post preprinted order sets and CPOE implementation	-Error reporting pre and post -Error reduction pre and post	No stats; percentages reported	-Findings: Error reduction by 40%; actual administration error report reduction of 25% -Recommendations: Implement preprinted order sheets and CPOE	6; moderate; supports strategies for error reporting and reduction
Cheng et al., 2012	FMEA	Prospective QI study; preimplementation and 12 months postimplementation	22,250 chemotherapy orders; inpatient and outpatient	Determine effect of integrating CPOE on error reduction	-Error reduction pre and post	Chi-square; percentages	-Finding: Error reduction from 3.34% to 0.40% (p = 0.04) -Recommendations: Use FMEA to evaluate safety risks; implement CPOE	6; moderate; supports strategy for error reduction
Looper et al., 2015	SBAR; PDCA	Prospective QI study; preimplementation and 6 months postimplementation	48 cancer centers; 282 medical records; pediatric patients; inpatient and outpatient	Determine compliance with implementation and use of standardized and safe chemotherapy	Use of and compliance with guidelines and standards for safe chemotherapy administration	No stats; percentages reported	-Finding: Compliance with standards 100% in 6 months -Recommendation: Standardize processes for administration; order verification for sequence and	6; high; shows effectiveness of implementing multiple care standardizations in various settings

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
				administration techniques			exact administration times imperative; use consistent parameters for documentation	
Walsh et al., 2009	None	Retrospective QI study; record review	1,262 adult cancer patients with 10,995 medication administrations; 117 pediatric cancer patients with 913 medication administrations; 3 adult clinics; 1 pediatric clinic; 4 different states	Determine rates and type of medication errors and system factors associated with errors	-Error rates -Error types -System based factors contributing to errors	Cronbach's alpha	-Findings: 112 errors including clinic and home self-administration errors; 7.1% (adult), 18.8% (pediatric); 64 of 112 potential to cause harm; 15 of 112 resulted in injury; 56% error during administration phase; -Recommendations: CPOE; physician order reviewers to improve communication	6; high; verifies nurse as key contributor to error prevention; supports known contributors to error and resulting strategies for error recognition and reporting
Walsh et al., 2013	None	Prospective observational study; interview and observation	242 medication administrations; pediatric cancer patients; in-home care	Determine frequency of and strategies to reduce preventable medication errors including chemotherapy and supportive care drugs	-Error occurrences -Patient/family involvement -Patient education -Communication processes	Interrater reliability; percentages	-Findings: Errors related to either oral chemotherapy or supportive care agents caused harm in 3.6 per 100 patients (95% CI: 1.7-5.5); errors with potential to cause harm in 36.3 per 100 patients (95% CI: 29.3-43.3) -Recommendation: Improve and standardize care transition communication, patient education, compliance monitoring	6; moderate to high; supports known contributors to error and resulting strategies for error recognition and reporting
Nelson et al., 2014	None	Policy development; literature review	Unspecified oncology setting	Develop proactive policy and procedure to ensure rapid response to accidental chemotherapy overdose	Optimize chemotherapy dosing safety	No stats; anecdotal process	-Recommendations: Establish practice guidelines facilitating early recognition and immediate action to chemotherapy overdose; identify potential interventions and assessments to promote safety; educate patients and family regarding treatment plan and	6; moderate; evidence and recommendations to support error recognition and reporting

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
required monitoring								
Schwappach et al., 2010	None	Qualitative descriptive study; focus groups; complement study to Schwappach & Wernli, 2010	11 oncology nurses; inpatient and outpatient oncology	Explore nurses' perception of patient involvement in error prevention	Four themes: involving patients; challenges and barriers; responsibility for safety; learning and reflecting	No stats; percentages and anecdotal reports	-Findings: Affirmative attitudes and positive experiences engaging patients yet challenging; engagement improved trust and confidence in care -Recommendation: Skill building to engage patients	6; low; small study; good background information
Schwappach & Wernli, 2011	Theory of Planned Behavior	Cross-sectional, descriptive study; survey; follow-up to Schwappach et al., 2010	479 adult patients receiving chemotherapy	Explore acceptability of patients to exhibit error preventing behaviors	Response to vignettes of errors and unsafe acts related to chemotherapy administration	Cronbach's alpha, mean scale scores, multiple logistic regression analysis	-Findings: Patients' willingness to engage varied (57-96%, $p < 0.001$ ) due to barriers of health, knowledge, and staff time -Recommendation: Staff awareness of subjective behavior and attitudes of patients when engaging in error prevention	6; low; hypothetical analysis; good background information; supports strategies for error recognition
Harris et al., 2014	None	Cross-sectional, descriptive study; CPMEP questionnaire	100 caregivers; pediatric cancer setting	Explore caregivers' characteristics and perception of drug administration safety	-Perceptions of safety -Knowledge of strategies to prevent errors -Willingness to partner with professionals in error prevention	Cronbach's alpha; t-tests	-Findings: Caregivers have apprehension about responsibility to look for errors; hesitant to discuss fears; willing to partner to prevent errors -Recommendation: Enhance education and engagement of caregivers ( $r = 0.64$ )	6; low; variables and reliability differ greatly; good background information; supports strategies for error recognition



Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
Trbovich et al., 2010	None	Direct observational study; shadowing	17 outpatient oncology nurses over 3 hours; 4 months	Explore nature and frequency of interruptions during chemotherapy administration and the effects on task efficiency	Nature, frequency, timing of interruption during specific tasks	Interrater reliability; no stats; percentages reported	-Finding: Nurses interrupted 22% while administering treatments and 29% while performing safety-related tasks; task completion times were greater for those with interruptions. -Recommendation: Decrease interruptions with time-out, visual recognition of chemotherapy nurse	6; low; small sample; good background information on contribution to errors; supports strategies for error reduction
Sheridan-Leos, 2007	None	Descriptive QI study; systems analysis	12 novice oncology nurses; community hospital; 24 months	Implement effective strategies for error prevention by new nurses following determination of potential chemotherapy errors	Error prevention following standardized education and system-based safety initiative	No stats; Anecdotal	-Recommendations: Proactive approach to error prevention; cultivating culture of safety with proper standards, techniques, communication, and ongoing education and competency assessment	6; low; valuable inclusion in background information; utilizes recommended education process
Prakash et al., 2014	None	Descriptive study; direct observation; 3-phase simulation; 6 months; pre-intervention, focus group, postintervention; follow-up to Trbovich et al., 2010	18 oncology nurses preintervention; 19 oncology nurses postintervention; simulation laboratory setting	Explore association between interruptions and specific pretreatment and administration errors, effectiveness of focus group work to reduce interruptions and errors	Interruption error rates during medication verification and administration tasks, before and after focus group intervention work to decrease distractions	Interrater reliability; Fisher's exact test	-Findings: Most significant decrease in errors postintervention related to dose verification (17% reduction; $p=0.153$ ), volume verification (31% reduction; $p=0.038$ ), pump program (34% reduction; $p=0.017$ ), and IV push administration (57% reduction; $p=0.001$ ) -Recommendations: No-interruption zones, visual timing devices, speaking aloud during verification activities, reminder signage	6; moderate; hypothetical situation with high number of "errors" presented in simulation event; good background information on types of distractions and errors; supports strategies for error recognition and reduction

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
White et al., 2010	None	Direct observational study; simulated laboratory	13 oncology nurses; outpatient care; simulation laboratory; preintervention, new checklist implemented, postintervention	Compare nurses' ability to detect errors with two-person verification using old and new chemotherapy administration checklists	Rates of specific types of errors recognized during medication administration using old and new administration checklists	2x4 repeated measures; ANOVA	-Findings: Error detection decreased with new checklist (55% to 38% F [1,9] = 26.64, p<0.01) -Recommendation: Step-by-step checklist beneficial to error prevention	6; low; small sample; good background information on documentation; supports strategies for error recognition
Spruill et al., 2009	Team STEPPS	Descriptive QI study; preimplementation chart review and postimplementation chart review	90 chemotherapy treatment chart reviews; 6 months	Describe compliance with new bedside check for chemotherapy patient identification	Consistency of new bedside checks	No stats; percentages reported	-Finding: 100% compliance with no patient misidentification within 6 months -Recommendation: Implement additional bedside patient identification check	6; low; only compliance checked; good background information on documentation; supports strategy for error recognition
Nerich et al., 2010	None	Epidemiologic observational survey	14,854 chemotherapy orders; 1 year	Determine the potential incidence and clinical impact of chemotherapy prescribing errors discovered by pharmacists	Potential incidence and severity of chemotherapy prescribing errors discovered by pharmacists	Multivariate analysis; stepwise logistic regression model; Fisher exact test; chi-square	-Findings: 15 errors per 1000 orders; 3.7% possibly fatal if not recognized; 1% potentially having clinical impact (CI = 95%, p <0.02); dosage error most common 20% of the time by occasional CPOE users -Recommendation: Enhance order analysis and training of occasional CPOE users	6; low; describes pharmacists reported errors but relevant for impact of strategies for error recognition

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
Bourmaud et al., 2014	None	Cross-sectional survey	157 oncologists employed by 112 hospitals; outpatient oral chemotherapy prescriptions	Gather exhaustive information on oral chemotherapy prescribing practices	-Patient education provided -Method of writing prescription -Monitoring procedures for compliance -Incidence of serious adverse events	No stats; percentages reported	-Findings: 56.1% used handwritten prescriptions; 23% with no compliance checks; 39% report serious adverse events -Recommendations: Standardize oral chemotherapy prescribing standards	6; low; describes physician orders but relevant for impact of strategies for error reduction
Watts & Parsons, 2013	None	Prospective QI study; preimplementation, new surveillance system, postimplementation	>20,000 chemotherapy orders; pediatric oncology setting; 3 years	Determine effect of new pharmacy prospective surveillance system on error reduction	Incidence of errors per patient encounter and per prescription; number of errors intercepted prior to reaching patient	No stats; percentages reported	-Findings: Error rates 6/1000 patient encounters and 3.9/1000 prescriptions reduced to 3/1000 and 1.8/1000 after surveillance implemented; 92% errors intercepted before reaching patient; no patient harm reported	6; low; describes pharmacists reported errors but relevant for impact of strategies for error recognition
Ranchon et al., 2011	None	Prospective QI study; cost analysis	6,607 chemotherapy orders; inpatient oncology	Assess number and impact of chemotherapy errors	Frequency, severity, and cost of errors	Univariate analysis; chi-square; Kappa stats	-Findings: 341 errors in 6,607 orders (5.2%); 91% prescriptive errors; 13 reached patients -Recommendations: Need for development of systematic preventive actions to reduce medication errors; continue regular review for errors	
Ranchon et al., 2012	None	Epidemiologic observational study	17,150 chemotherapy prescriptions; inpatient and outpatient oncology	Identify predictors of prescription errors involving antineoplastic agents	-Patient factors -Protocol complexity -Provider writing order -Modified protocols -Type of care setting	Univariate analysis; chi-square; multivariate analysis	Findings: 540 errors in records (3.15%); highest risk factors: BSA >2 (p = 0.005), protocols 3 or more drugs (p <0.001), protocol needing at least one modification (p = 0.03), prescriptions written by resident (p<0.001)	6; moderate; supports known contributors to errors and strategies for error reduction

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
DuBeshter et al., 2006	None	Prospective QI study	2558 drug administrations; inpatient and outpatient oncology; 12 months	Determine types of errors in chemotherapy dosing using CPOE	Errors in drug selection, dose calculations, decimal-point errors, exceeding warning level set	No stats; percentages reported	-Findings: Errors only found in dose warning level exceeded -Recommendation: Higher awareness of dose limits and upgrading CPOE	6; low; supports strategies for error recognition and reduction
Jia, Zhang, Chen, Zhao, & Zhang, 2016	None	Literature review	20 studies including systematic reviews	Evaluate effects of clinical decision support on medication safety	Rate of errors	75% found significant impact on medication safety	regularly -Recommendations: Clinical decision support reduces medication errors	6; moderate; supports known contributors to errors and strategies for error reduction
Harris & Northfelt, 2005	None	Case study for QI initiative; literature review	1 patient; chemotherapy error occurrence causing patient harm	Describe potential models for chemotherapy error reporting based on case study	None	No stats	-Findings from literature review: Postulates comprehensive reporting will lead to more robust understanding and reduced error incidence -Recommendations: multiple systems, unit, individual	7; moderate; good composite literature review; information on documentation; strategies for error recognition, reporting, and reduction
Schulmeister, 2006	None	Literature review	Not stated	Review principles of safe chemotherapy administration and key actions to prevent errors	None	No stats	-Recommendations: Recognize mistakes occur; create culture of safety; clear, unambiguous chemotherapy orders; ongoing staff education and reliable resources; reliable patient identification processes; establish error reporting process	7; low; number of reviews not provided; use as background information on specific error prevention processes
Schulmeister, 2008	None	Literature review	Not stated	Explore process of patient identification	None	No stats	-Recommendation: Consistently verify patient	7; low; number of reviews not provided;

Citation	Theoretical Framework	Design and/or Methods	Sample and Setting	Aim and Major Variables Studied	Outcomes Measured or Discussed	Data Analysis	Findings and Recommendations	Level and Quality of Evidence
				and factors contributing to patient misidentification prior to oncology care			identity using two unique patient identifiers	background information on documentation and error recognition

*Note.* Publications are listed from highest level of evidence to lowest level of evidence. Levels of evidence are based on the rating system for the hierarchy of evidence for intervention/treatment questions (Melnik & Fineout-Overholt, 2015, p. 11).

FMEA – Failure Mode Effects Analysis quality improvement model

SBAR – Situation Background Assessment Recommendation quality improvement model

PDCA – Plan-Do-Check-Act quality improvement model

PRISMA – Preferred Reporting Items for Systematic Reviews and Meta-Analysis model

AIRE – Appraisal of Indicators through Research and Evaluation instrument

CPMEP – Caregiver Partnership in Medication Error Prevention questionnaire

ANOVA – Analysis of Variance

RISQ – Reporting to Improve Safety and Quality error database

Table 4

*Synthesis of Best Practice Recommendations: Critical Behaviors and Unit and System-based Structures and Processes that Support Critical Behavior and Drive Compliance to Guidelines/Standards for Chemotherapy Error Prevention, Recognition, and Reporting*

Supporting System-based Structures	Supporting Unit-based Processes	Critical Individual Nurse Behaviors
<ul style="list-style-type: none"> <li>-Adopt guidelines and standards (ASHP, 2015; IHI, 2012; JC, 2016; Neuss et al., 2013; Neuss et al., 2016; Polovich et al., 2014)</li> <li>-Recognize mistakes occur and their potential impact (AHRQ, 2016; Brady et al., 2009; Harris &amp; Northfelt, 2005; JC, 2016)</li> <li>-Prioritize the error issue, allow adequate staff time to implement, evaluate and maintain change (Brady et al., 2009; Harris &amp; Northfelt, 2005)</li> <li>-Proactively cultivate a culture of safety (AHRQ, 2016; Fyhr et al., 2015; Farag et al., 2017; Hung et al., 2016; JC, 2016; Richardson &amp; Storr, 2010; Schulmeister, 2006; Sheridan-Leos, 2007; Trbovich et al., 2010)</li> <li>-Implement preprinted order sets or other clear unambiguous ordering process (Harris &amp; Northfelt, 2005; JC, 2005; JC, 2016; Robinson, et al., 2006; Schulmeister, 2006)</li> <li>-Implement CPOE (Cheng et al., 2012; Harris &amp; Northfelt, 2005; ISMP, 2016; Kullberg, et al., 2013)</li> <li>-Train all users for chemotherapy entry into CPOE (Nerich, et al., 2010).</li> <li>-Standardize chemotherapy prescription, education, and monitoring (Bourmaud et al., 2014; ISMP, 2016; Walsh et al., 2013; Weingart et al., 2010)</li> <li>-Implement CPOE upgrades (Gandhi et al., 2005): embedded checklists (Dobish et al., 2016); policies for vulnerabilities (Harris &amp; Northfelt, 2005); chemotherapy alerts, clinical decision support, vocabulary; order templates, barcodes (Baldwin &amp; DuBeshter et al., 2006; ISMP, 2016; Jia et al., 2016; Rodriguez, 2016; Ranchon et al., 2011; Watts &amp; Parsons, 2013)</li> <li>-Ensure environmental improvements to limit distractions (Farag et al., 2017; Harris &amp; Northfelt, 2005)</li> <li>-Establish guidelines for recognition and immediate action to chemotherapy overdose (Fyhr et al., 2015; Nelson et al., 2014)</li> <li>-Establish non-punitive reporting system that is comprehensive, quickly identifies the need for proactive or reactive actions (AHRQ, 2016; Brady et al., 2009; Fyhr et</li> </ul>	<ul style="list-style-type: none"> <li>-Implement guidelines and standards (ASHP, 2015; IHI, 2012; ISMP, 2016; JC, 2016; Neuss et al., 2013; Neuss et al., 2016; Polovich et al., 2014)</li> <li>-Provide comprehensive chemotherapy education, annual competency testing, and include simulation of error events (Brady et al., 2009; Daupin et al., 2016; Harris &amp; Northfelt, 2005; Neuss et al., 2013; Neuss et al., 2016; Polovich et al., 2014; Schulmeister, 2006)</li> <li>-Combine education with formal and informal evaluations (Daupin et al., 2016; Sheridan-Leos, 2007)</li> <li>-Assure safe preassessment practices with step-by-step checklist and indicators (White et al., 2010)</li> <li>-Include independent and two-person dose verification, dose limits, patient education (Harris &amp; Northfelt, 2005)</li> <li>-Consider employment of verification nurse (Baldwin &amp; Rodriguez, 2016)</li> <li>-Consider interprofessional order surveillance team (Markert et al., 2009)</li> <li>-Integrate no-interruption zones, visual timing devices, reminder signage (Prakash et al., 2014)</li> <li>-Assure precautions with investigational agents that have adequate references for staff (Gandhi, et al., 2005)</li> <li>-Improve transition of care communication (Walsh et al., 2013; Harris &amp; Northfelt, 2005)</li> <li>-Assure time for routine review of error occurrences by staff (Harris &amp; Northfelt, 2005)</li> <li>-Implement oncology practice guidelines and standards (ASHP, 2015; Fyhr et al., 2015; IHI, 2012; Neuss et al., 2013; Neuss et al., 2016; Polovich et al., 2014)</li> <li>-Assure error reporting system is available and feasible for use by nurses (Brady et al., 2009; Fyhr et al., 2015; Harris &amp; Northfelt, 2005; Nelson et al., 2014)</li> <li>-Motivate and encourage to overcome fear of punishment, time constraints, and a lack of perceived benefit to reporting errors (AHRQ, 2016; Fyhr et al., 2015; Harris &amp; Northfelt, 2005; Hung et al., 2016; McNab et al., 2016)</li> </ul>	<ul style="list-style-type: none"> <li>-Demonstrate compliance with practice guidelines and standards (ASHP, 2015; IHI, 2012; JC, 2016; Neuss et al., 2013; Polovich et al., 2014)</li> <li>-Enhance confidence and personal accountability (Schwappach &amp; Gehring, 2015)</li> <li>-Assure compliance with CPG and SoC processes for safe chemotherapy administration, including independent verification followed by two-person verification (Brady et al., 2009; Harris &amp; Northfelt, 2005; Looper et al., 2015; Neuss et al., 2013; Neuss et al., 2016; Smeulders et al., 2015)</li> <li>-Maintain vigilance in risk assessment (Endsley, 1995)</li> <li>-Speak aloud when performing verification activities (Prakash et al., 2014)</li> <li>-Initiate bedside patient identification (Spruill et al., 2009)</li> <li>-Consistently verify patient identity using two unique patient identifiers (Looper et al., 2015; Schulmeister, 2006; Schulmeister, 2008)</li> <li>-Eliminate interruptions: time outs, quiet verification areas (Harris &amp; Northfelt, 2005; Trbovich et al., 2010)</li> <li>-Consider patients partners in safety (Schulmeister, 2008).</li> <li>-Improve consent process to include full treatment information and planning (Nelson et al., 2014)</li> <li>-Educate and engage patients in error prevention behaviors (Kullberg et al., 2013; Schwappach et al., 2010)</li> <li>-Engage patients/caregivers in verification, monitoring, teach-back, reporting any symptoms, and document confirmation of engagement (Etchegaray et al., 2016; Harris et al., 2014; Kullberg et al., 2013; Schwappach, Hochreutener, &amp; Wernli, 2010; Schwappach &amp; Wernli, 2010; Shojania et al., 2001)</li> <li>-Be aware of barriers to engagement that are interpersonal and individual (Schwappach &amp; Wernli, 2011)</li> <li>- Demonstrate compliance with oncology practice guidelines and standards (AHRQ, 2016; ASHP, 2015; IHI, 2012; Neuss et al., 2013; Neuss et al., 2016; Polovich et al., 2014)</li> </ul>

<b>Supporting System-based Structures</b>	<b>Supporting Unit-based Processes</b>	<b>Critical Individual Nurse Behaviors</b>
al., 2015; Harris & Northfelt, 2005; Nelson et al., 2014; Schulmeister, 2006) -Investigate error reporting systems to meet organizational needs (Brady et al., 2009; Harris & Northfelt, 2005; Nelson et al., 2014) -Prioritize errors; allow adequate staff time to implement, evaluate and maintain (Harris & Northfelt, 2005) -Remember to learn from safety errors (AHRQ, 2016; Macrae, 2016)	-Offer open forums and individual sessions to build confidence in reporting and communication for advocacy (Schwappach & Gehring, 2015) -Provide team building and trust building work (Farag et al., 2017; Schwappach & Gehring, 2015)	-Consistently utilize error reporting system (Brady et al., 2009; Harris & Northfelt, 2005; Nelson et al., 2014) -Develop accountability (McNab et al., 2016; Schwappach & Gehring, 2015)

Table 5

*Theoretical Model Components Related to Overall Survey Intent*

<b>Overall Survey Themes</b>	<b>New World Kirkpatrick Model (NWKM): Level of Evaluation</b>	<b>Knowledge-to-Action (KTA): Action Cycle Phase</b>
Are changes in critical individual practice behaviors and supporting organizational processes perceived as needed by nurse participants following completion of the ONS/ONCC course?	Level Three: assesses perception of need for changes in critical behaviors and required drivers.	1. Phase Two: assesses acceptance of knowledge to specific practice environments. 2. Phase Five: monitors knowledge use.
Have changes in critical individual practice behaviors and supporting organizational processes been initiated by nurse participants as a result of the ONS/ONCC educational program content?	Level Three: assesses for initiated changes in critical behaviors and required drivers.	1. Phase Two: assesses adaptation of knowledge by stakeholders within specific practice environments. 2. Phase Five: monitors knowledge use.
What barriers may prevent nurse participants from initiating changes in critical individual practice behavior and supporting organizational processes?	Level Three: assesses issues related to accountability for initiating change in on-the-job learning.	1. Phase Three: assesses barriers to knowledge use related to stakeholders within specific practice environments. 2. Phase Five: monitors knowledge use.

(Graham et al., 2006; Kirkpatrick Partners, 2016)

Table 6

*Identification of Evidence-based Individual Chemotherapy Error Prevention Behaviors and Organizational Processes that are Supportive of and Compliant with Guidelines and Standards and Included in ONS/ONCC Chemotherapy and Biotherapy Certificate Course and based on Domain of Organizational Context as described in the Alberta Context Tool (ACT)*

Care Phase	Individual Error Prevention Behavior	Organizational Error Prevention Process	Guideline or Standard Reference	ACT Organizational Context Domain
Pretreatment	Confirm planned treatment education and consent for treatment with the patient.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, formal and informal interactions, structural and electronic resources
Pretreatment	Review current list of other medications for potential drug-drug interactions.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, structural and electronic resources
Pretreatment	Verify and document actual patient height and weight.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, structural and electronic resources
Pretreatment	Ensure and document two chemotherapy competent staff are engaged in verification process.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, formal interactions, structural and human resources
Pretreatment	Use of verification process minimally includes verification of each drug's name, dose, volume, administration route, administration rate, expiration date, and physical appearance.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, formal interactions, human resources, structural and electronic resources
Pretreatment	Use and document only generic drug names.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, structural and electronic resources
Pretreatment	Verify and document any specific dose and volume determination or change based on protocol or notation in orders.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, informal interactions, human resources, structural and electronic resources



Care Phase	Individual Error Prevention Behavior	Organizational Error Prevention Process	Guideline or Standard Reference	ACT Organizational Context Domain
Pretreatment	Verify and document cumulative dose received and dose limits based on body surface area and patient history for drugs requiring tracking.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, informal interactions, structural and electronic resources
Pretreatment	Verify and document correct use of hazardous drug label.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, human resources, structural and electronic resources
Pretreatment	Verify and document administration sequence of drugs in regimen.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, structural and electronic resources
Pretreatment	Two individuals verify and document patient identification at bedside.	Policy and procedure to support task within verification process	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, formal interactions, human resources, structural and electronic resources
Administration	Utilize infusion pump to eliminate gravity infusions.	Policy and procedure to support task within administration process	Polovich et al., 2014	Leadership, culture, structural and electronic resources
Administration	Use infusion set-up with immediate access to primary flush line.	Policy and procedure to support task within administration process	Polovich et al., 2014	Leadership, culture, structural and electronic resources
Administration	Assess and document site assessment.	Policy and procedure to support task within administration process.	Polovich et al., 2014	Leadership, culture, structural and electronic resources
Administration	Assess and document treatment tolerance including any immediate effects.	Policy and procedure to support task within administration process.	Neuss et al., 2013; Polovich et al., 2014	Leadership, culture, informal interactions, structural and electronic resources

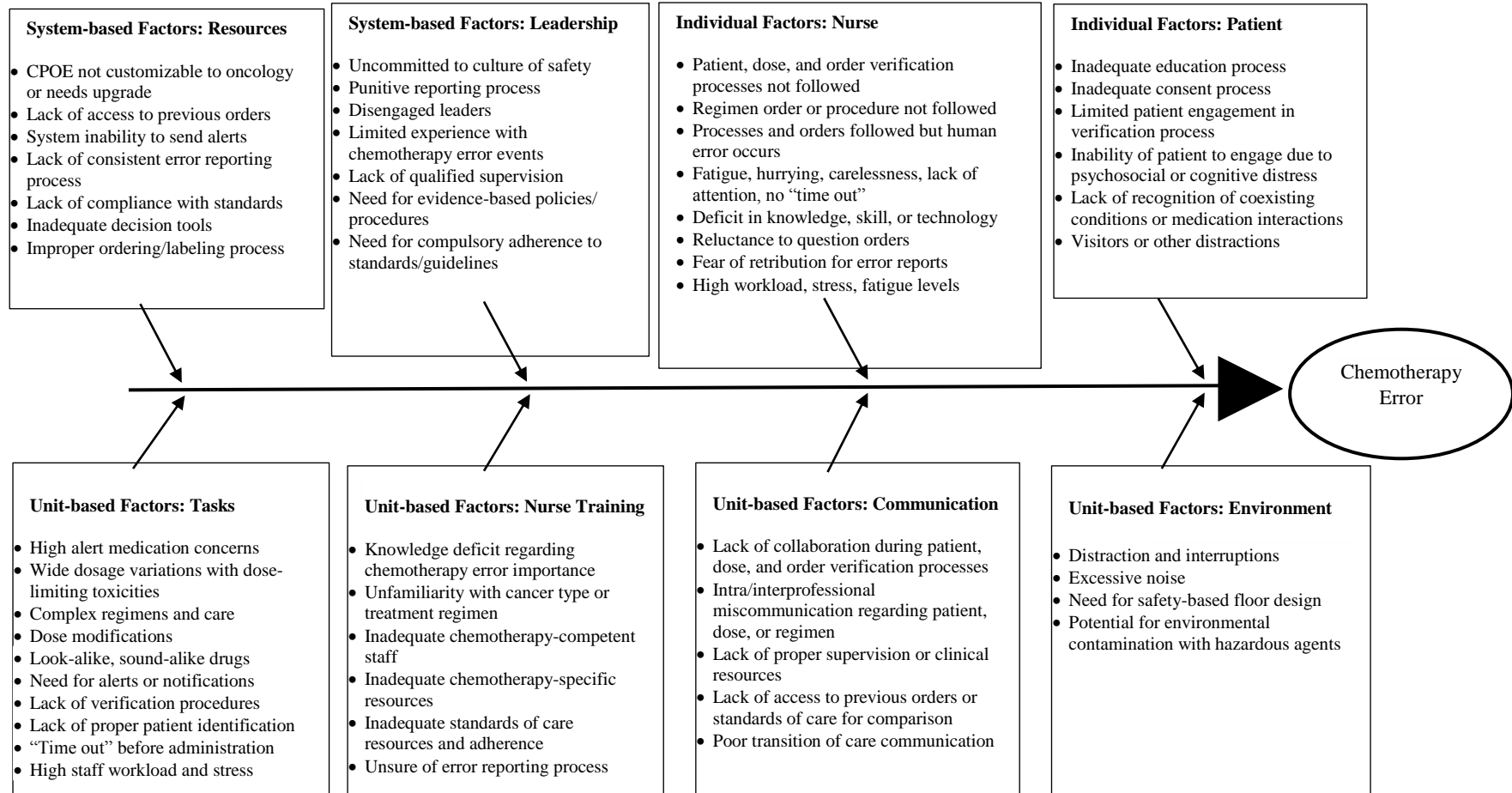
(Neuss et al., 2013; Polovich et al., 2014)

## Appendix B: Figures and Diagrams

## Figures B1, B2, B3, B4, B5

Figure 1

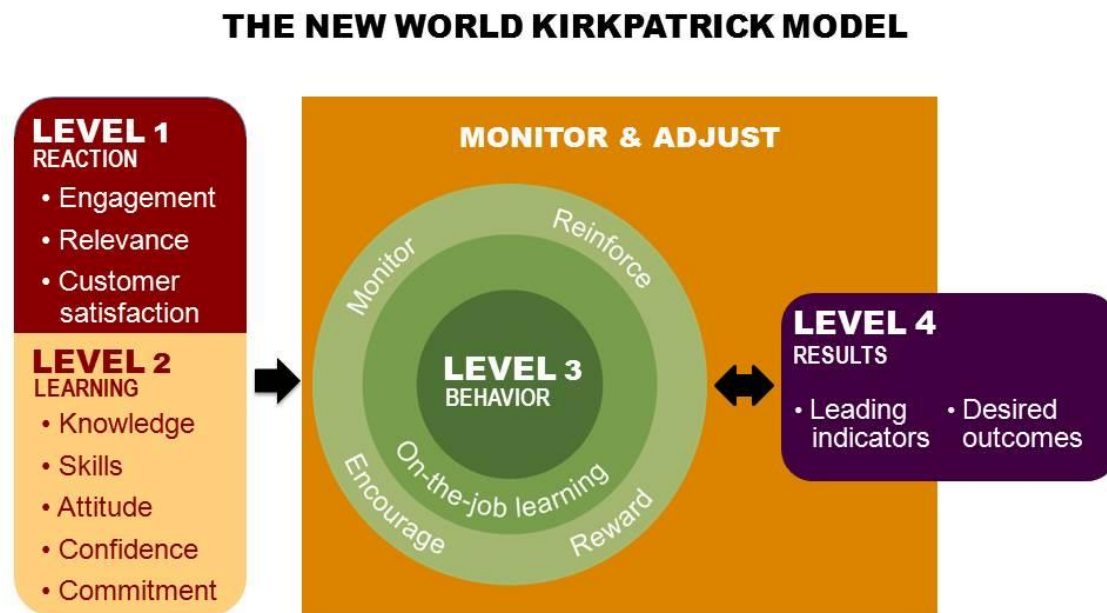
*Root Cause Analysis of Chemotherapy Errors Utilizing Ishikawa (Fishbone) Diagram (Warren, 2014)*



(ASCO, 2016; AHRQ, 2016; ASHP, 2015; CCO, 2012; CCO, 2014; Farag et al., 2016; Fyhr et al., 2015; Hung et al., 2016; IHI, 2012; IOM, 1999a; IOM, 2013; ISMP, 2016; Keers et al., 2013; Kloth, 2010; Lennes et al., 2016; Nelson et al., 2014; Neuss et al., 2013; Neuss et al., 2016; Polovich, 2015; Polovich, et al., 2014; Schulmeister, 2006; Schulmeister, 2008; Schwappach & Wernli, 2011; Walsh et al., 2009; Warren, 2014; Weber & Sidorov, 2014)

Figure 2

*The New World Kirkpatrick Model of Evaluation (NWKM)* (Kirkpatrick Partners, 2016)<sup>1</sup>



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Figure 3

*The Knowledge-to-Action (KTA) Framework with Action Cycle (Graham et al., 2006)<sup>2</sup>*

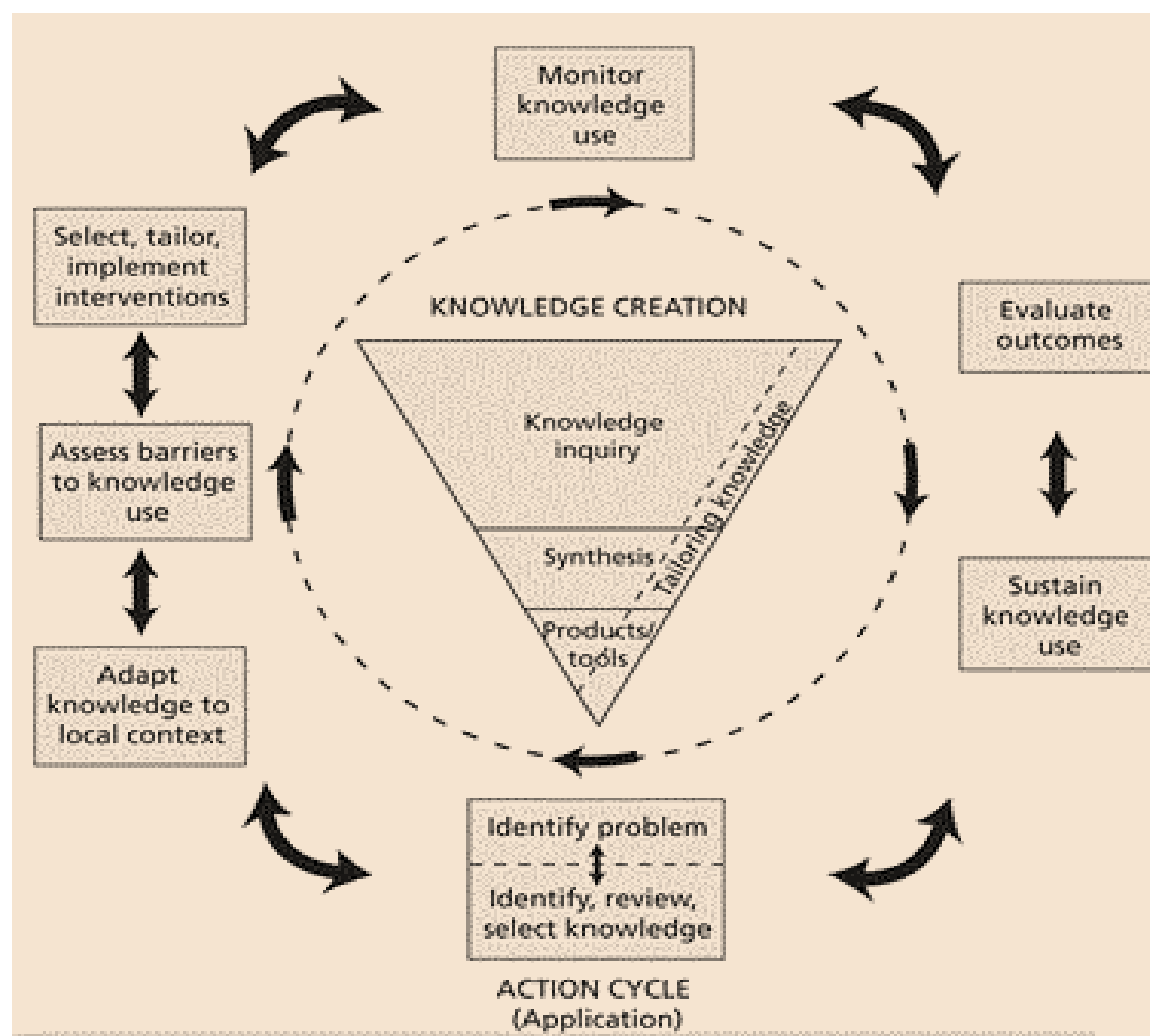
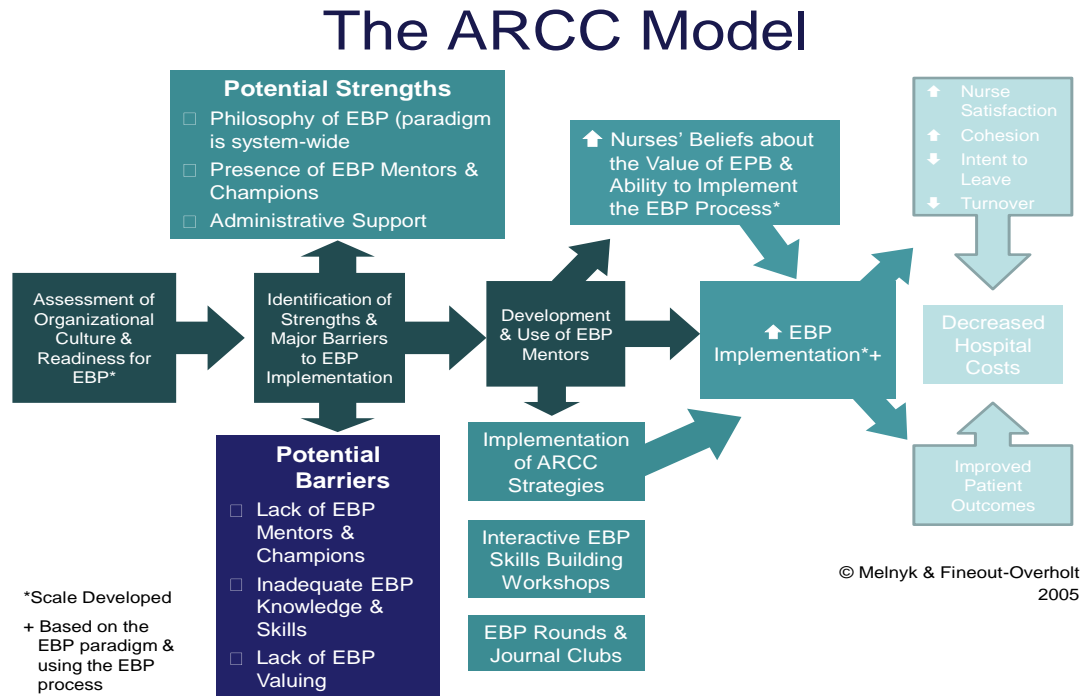


Figure 4

*The Evidence-based Advancing Research and Clinical Practice through Close Collaboration (ARCC®) Model* (Melnik, 2012; Melnyk & Fineout-Overholt, 2015; Melnyk, Fineout-Overholt, Gallagher-Ford, & Stillwell, 2011; Melnyk et al., 2017)<sup>3</sup>



The Conceptual Framework to Support the EBP Paradigm

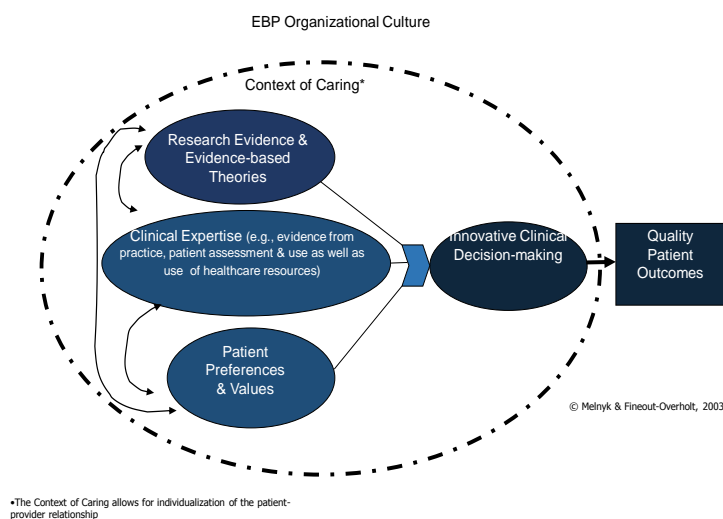
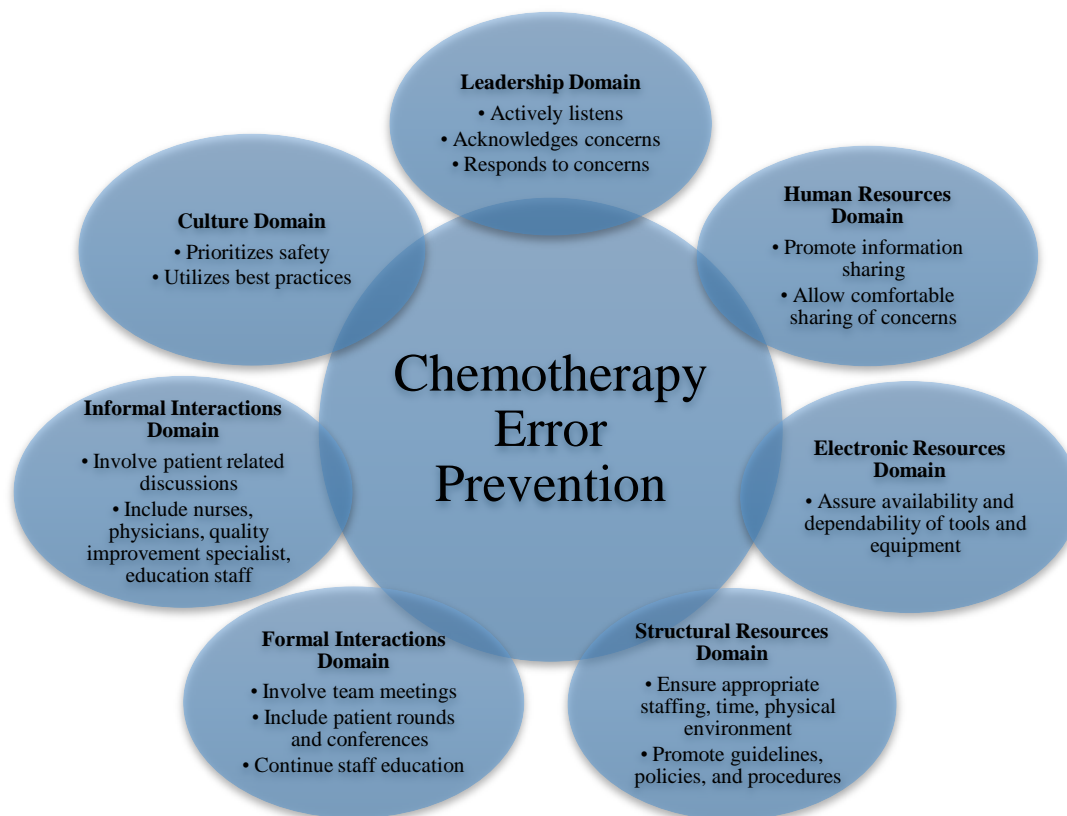


Figure 5

*The Alberta Context Tool (ACT) Applied to the Facilitation of Chemotherapy Error Prevention. Image created based on Domains of Care within the ACT Acute Care Nursing Version and used to develop list of potential barriers to practice change (Squires et al., 2014).*



## Appendix C: Project Survey

### Chemotherapy Error Prevention Survey Invitation and Content

#### Chemotherapy Error Prevention Survey Invitation

Did you know most chemotherapy errors are recognized during critical pretreatment and treatment administration nursing tasks? As the final checkpoint prior to treatment administration, the nurse's role in recognizing and reporting chemotherapy errors is vitally important to prevent patient harm. The foremost proactive strategy to enhance the nurse's role in preventing chemotherapy errors is comprehensive education and subsequent development of chemotherapy-competent nurses.

Because you have successfully completed the comprehensive ONS/ONCC Chemotherapy and Biotherapy Certificate course, ONS desires to know how you have improved practice to address chemotherapy error prevention. ONS is inviting you to participate in a survey to assess how you have used knowledge attained from the course to initiate individual and organizational change. The survey reflects course and e-book content specific to chemotherapy error prevention.

The survey is estimated to take less than 10 minutes to complete, and all survey responses will be anonymous and your personal information will not be identified. Survey outcomes will be included in a future ONS publication. The data collected will be used to enhance current and future chemotherapy educational offerings, and to determine the need for tools to overcome barriers to practice change.

To participate in the survey, please go to the following link: [ ]

If you have questions about this survey, please email [twyant@ons.org](mailto:twyant@ons.org).

#### Chemotherapy Error Prevention Survey Content

Thank you for participating in the Chemotherapy Error Prevention survey! The survey is estimated to take less than 10 minutes to complete. All survey responses are anonymous and your personal information will not be identifiable.

**Definition:** For this survey, "chemotherapy" is considered to be any antineoplastic agent given by the intravenous route and used to treat cancer.

**About Your Practice:** Please select the appropriate answers related to your level of practice, nursing experience, and care setting.

1. What is your age?

- ☐ 20-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60-69
- ☐ ≥ 70

2. What is the highest nursing degree you have attained?
- ☐ Associate degree
  - ☐ Diploma
  - ☐ Baccalaureate degree
  - ☐ Master's degree
  - ☐ Doctoral degree
3. Which professional oncology certification credentials have you attained? (Select all that apply)
- ☐ OCN®
  - ☐ AOCN®
  - ☐ AOCNS®
  - ☐ AOCNP®
  - ☐ CBCN®
  - ☐ BMTCN®
  - ☐ CPHON®
  - ☐ No oncology certification
4. How many years have you practiced nursing?
- ☐ <1
  - ☐ 1-3
  - ☐ 4-9
  - ☐ 10-14
  - ☐ 15-19
  - ☐ 20-24
  - ☐ 25+
5. How many years have you practiced oncology nursing?
- ☐ <1
  - ☐ 1-3
  - ☐ 4-9
  - ☐ 10-14
  - ☐ 15-19
  - ☐ 20-24
  - ☐ 25+
  - ☐ No oncology experience
6. How many years of experience do you have in chemotherapy administration?
- ☐ <1
  - ☐ 1-3
  - ☐ 4-9
  - ☐ 10-14
  - ☐ 15-19
  - ☐ 20-24
  - ☐ 25+
  - ☐ No chemotherapy experience
7. What is the care setting in which the majority of your chemotherapy nursing hours (administration or post-treatment care) are spent?
- ☐ Inpatient oncology
  - ☐ Inpatient non-oncology
  - ☐ Intensive care



- ☐ Ambulatory oncology
  - ☐ Other ambulatory or infusion center
  - ☐ Bone marrow or stem cell transplant unit
  - ☐ Hospice/palliative care
  - ☐ Home care
  - ☐ Long-term care
  - ☐ Other non-oncology care
  - ☐ Do not provide chemotherapy care
8. What is the patient population to which your chemotherapy nursing care is provided? (Select all that apply)
- ☐ Adult
  - ☐ Pediatric
  - ☐ Diagnosis- or site-specific
  - ☐ Do not provide chemotherapy care
9. In which U.S. state do you practice?
- ☐ Drop-down list of U.S. states with international option
10. In what month and year did you complete the ONS/ONCC Chemotherapy and Biotherapy Certificate course?
- ☐ October 2015
  - ☐ November 2015
  - ☐ December 2015
  - ☐ January 2016
  - ☐ February 2016
  - ☐ March 2016

***Pretreatment Error Prevention:*** Select one response that best reflects your perception of changes you have made ***during pretreatment care*** since completing the ONS/ONCC Chemotherapy and Biotherapy Certificate course.

1. Confirm planned treatment education and patient consent for treatment are documented.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
2. Review allergies and current list of all medications for potential interactions.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.

3. Verify and document actual patient height and weight.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
4. Ensure and document order completeness by verifying each drug's name, dose, volume, administration route, administration rate, expiration date, and physical appearance.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
5. Ensure and document that two chemotherapy competent staff are engaged in chemotherapy order verification process.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
6. Use and document only generic (not brand or trade) drug names.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
7. Verify and document dose variations and rationale for each variation.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
8. Verify and document any drug-specific cumulative dose and dose limits.
  - ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.

9. Verify and document administration sequence of drugs in regimen.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
10. Verify and document correct hazardous drug labeling.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
11. Ensure and document that two individuals verify patient identification.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.

***Treatment Administration Error Prevention:*** Select one response that best reflects your perception of changes you have made ***when administering treatment*** since completing the ONS/ONCC Chemotherapy and Biotherapy Certificate course.

1. Utilize infusion pump to eliminate gravity infusions.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
2. Use infusion set-up with immediate access to primary flush line and emergency equipment.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.
3. Assess and document administration site and its appearance.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.

4. Assess and document treatment tolerance including any immediate effects.
- ☐ I consistently performed this behavior prior to course completion and no change was needed.
  - ☐ I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.
  - ☐ I did not perform this behavior prior to course completion and have since started performing the behavior.
  - ☐ I did not perform this behavior prior to course completion and still do not perform it.

**Organizational Error Prevention Policies and Procedures:** Select one response that best reflects your perception of changes you have been involved in *within your organization* since completing the ONS/ONCC Chemotherapy and Biotherapy Certificate course.

1. Policies and procedures that support and detail the steps and components needed in the pretreatment nursing verification process.
  - ☐ I know effective policies and procedures were already in place prior to course completion and no change was needed.
  - ☐ I know these policies and procedures were already in place, but I started discussions or approached peers and/or nurse leaders about the need to review or revise specific policies and procedures.
  - ☐ I know these policies and procedures were already in place, but do not know if changes are needed.
  - ☐ I know these policies and procedures were not previously in place and are still not in place.
  - ☐ I am unsure if these policies and procedures are in place.
2. Policies and procedures that support and detail the steps and components needed in the treatment administration process.
  - ☐ I know effective policies and procedures were already in place prior to course completion and no change was needed.
  - ☐ I know policies and procedures were already in place, but I started discussions or approached peers and/or nurse leaders about the need to review or revise specific policies and procedures.
  - ☐ I know these policies and procedures were already in place, but do not know if changes are needed.
  - ☐ I know these policies and procedures were not previously in place and are still not in place.
  - ☐ I am unsure if these policies and procedures are in place.
3. Policies and procedures that support and detail nursing pretreatment and treatment administration documentation requirements.
  - ☐ I know effective policies and procedures were already in place prior to course completion and no change was needed.
  - ☐ I know policies and procedures were already in place, but I started discussions or approached peers and/or nurse leaders about the need to review or revise specific policies and procedures.
  - ☐ I know these policies and procedures were already in place, but do not know if changes are needed.
  - ☐ I know these policies and procedures were not previously in place and are still not in place.
  - ☐ I am unsure if these policies and procedures are in place.

**Barriers to Individual Practice Change:** Please select any and all statements that reflect your perception of challenges you may encounter or have encountered when initiating error prevention change in your own personal practice.

- ☐ I am unsure or unaware of the chemotherapy error prevention strategies for nurses that are recommended in the guidelines and standards.
- ☐ I am unsure or unaware of nursing policies and procedures in my practice setting that may help me to prevent chemotherapy errors.

- ☐ I do not feel the chemotherapy educational program provided enough information about how I can prevent chemotherapy errors.
- ☐ I do not have enough time to make changes in my pretreatment and treatment administration tasks.
- ☐ I am reluctant to change my own practice because it will be different from the practice of other nurses.
- ☐ I have mentioned changes to other nurses but they have questioned the changes I want to make.
- ☐ I need to find ways to more effectively engage patients in chemotherapy error prevention.
- ☐ I believe the physician and pharmacist are responsible to verify orders to prevent chemotherapy errors.
- ☐ I believe that using computerized order systems and electronic health records eliminates the risk for chemotherapy errors.
- ☐ I have not encountered any barriers to initiating change in my own practice or did not need to initiate change in my own practice.

**Barriers to Organizational Policy and Procedure Change:** Please select any and all barriers that reflect your perception of challenges you may encounter or have encountered in initiating *change to error prevention policies and procedures within your practice setting*. Examples of this type of change include the development or revision of policies, procedures, documentation forms, and quality improvement monitoring.

- ☐ Leaders in my organization lack knowledge regarding error prevention strategies.
- ☐ Leaders in my organization lack understanding regarding the need for change.
- ☐ Leaders in my organization are not receptive to ideas for change.
- ☐ My organization does not prioritize chemotherapy error prevention strategies.
- ☐ Policies and procedures in my organization do not or may not include provide best practices for chemotherapy error prevention.
- ☐ Effective interprofessional communication is lacking in my organization.
- ☐ Ongoing education and monitoring for the prevention of errors is lacking in my organization.
- ☐ Inadequate staffing and time constraints affect compliance with policies and procedures in my organization.
- ☐ Evidence and resources to validate the need for change in my organization are lacking.
- ☐ Electronic ordering and documentation systems are not easily changed or are not integrated in my organization.
- ☐ The culture in my organization makes me reluctant to offer suggestions.
- ☐ Recommending additional error prevention strategies in policies and procedures may lead to a higher risk for punitive action if those tasks are not performed.
- ☐ I have not encountered any barriers to initiating change in policies and procedures or did not need to initiate change to policies and procedures.

**Additional Information:** When providing chemotherapy care, please describe what you do differently that helps to identify or prevent chemotherapy errors as a result of the knowledge you have attained and guidelines that were provided in the ONS/ONCC Chemotherapy Certificate course and accompanying e-book?

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Thank you for participating in the Chemotherapy Error Prevention survey! The data collected will be used to enhance current and future chemotherapy educational offerings, and to determine the need for tools to overcome barriers to practice change. If you have questions about this survey, please email [twyant@ons.org](mailto:twyant@ons.org).

Appendix D: Findings  
Tables 1, 2, 3, 4, 5, 6, 7, 8

Table 1

*Participant Characteristics (N = 334)*

Characteristics	Frequency (%)
<b>Age</b>	
20-29 years	60 (18.0)
30-39 years	91 (27.3)
40-49 years	79 (23.7)
50-59 years	80 (24.0)
60-69 years	24 (7.0)
<b>Nursing Degree</b>	
Associate	95 (28.4)
Diploma	19 (5.7)
Baccalaureate	185 (55.4)
Master's	32 (9.6)
Doctoral	3 (0.9)
<b>Oncology Certification*</b>	
Oncology Certified Nurse (OCN®)	143 (42.8)
Advanced Oncology Certified Nurse (AOCN®)	8 (2.4)
Advanced Oncology Clinical Nurse Specialist (AOCNS®)	5 (1.5)
Advanced Oncology Certified Nurse Practitioner (AOCNP®)	2 (0.6)
Certified Breast Care Nurse (CBCN®)	14 (4.2)
Bone Marrow Transplant Certified Nurse (BMTCN®)	7 (2.1)
Certified Pediatric Hematology Oncology Nurse (CPHON®)	1 (0.3)
No oncology certification	158 (47.3)
<b>Years of Nursing Practice</b>	
<1	6 (1.8)
1-3	56 (16.6)
4-9	81 (24.5)
10-14	51 (15.0)
15-19	29 (8.8)
20-24	28 (8.5)
≥25	83 (24.8)
<b>Years of Oncology Nursing Practice</b>	
0	1 (0.3)
<1	23 (6.9)
1-3	95 (28.5)
4-9	84 (25.2)
10-14	41 (12.3)
15-19	39 (11.4)
20-24	19 (5.7)
≥25	32 (9.7)
<b>Years of Chemotherapy Nursing Care</b>	
<1	52 (15.3)
1-3	82 (24.6)
4-9	77 (23.1)
10-14	40 (12.0)
15-19	38 (11.5)
20-24	20 (6.0)
≥25	25 (7.5)

Table 1 (continued)

Characteristics	Frequency (%)
<b>Primary Care Setting</b>	
Inpatient oncology	112 (33.6)
Inpatient non-oncology	12 (3.6)
Intensive care	3 (0.9)
Outpatient oncology	114 (34.2)
Infusion center	67 (20.1)
Bone marrow transplant (BMT)	22 (6.4)
Hospice/palliative care	2 (0.6)
Other	1 (0.3)
Do not provide chemotherapy care	1 (0.3)
<b>Month and Year of Course Completion</b>	
October 2015	51 (15.2)
November 2015	53 (15.8)
December 2015	70 (21.2)
January 2016	48 (14.5)
February 2016	46 (13.6)
March 2016	66 (19.7)

\*Participants selected any and all oncology certifications held, with five selecting more than one.

*Note:* Characteristics correspond to “About Your Practice” survey questions (See Appendix C).

Table 2

*Perceived Impact on Practice:**Individual Pretreatment Error Prevention Behavior Variables (N = 334)*

Pretreatment Error Prevention Behaviors	Consistently performed; no change needed <sup>1</sup>	Sometimes or mostly performed; more aware of need to perform <sup>2*</sup>	Did not perform; have started performing <sup>3*</sup>	Did not perform; still do not perform <sup>4</sup>
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
1. Confirm treatment education and patient consent are documented.	243 (73.0%)	22 (6.6%)*	4 (1.2%)*	65 (19.2%)
2. Review allergies and current medication list for potential interactions.	232 (69.4%)	16 (4.8%)*	7 (2.1%)*	79 (23.7%)
3. Verify and document actual patient height and weight.	257 (77.4%)	26 (7.9%)*	5 (1.5%)*	46 (13.2%)
4. Document order completeness by verifying each drug's name, dose, volume, administration route and rate, expiration date, and physical appearance.	272 (81.9%)	16 (4.8%)*	3 (0.9%)*	43 (12.4%)
5. Ensure and document two chemotherapy competent staff engaged in order verification.	283 (85.0%)	20 (6.0%)*	5 (1.5%)*	26 (7.5%)
6. Use and document only generic (not brand or trade) drug names.	109 (32.7%)	54 (16.3%)*	23 (6.9%)*	148 (44.1%)
7. Verify and document dose variations and rationale for variations.	186 (56.0%)	39 (11.8%)*	13 (3.9%)*	96 (28.3%)
8. Verify and document drug-specific cumulative dose and dose limits.	144 (43.0%)	63 (19.1%)*	27 (8.2%)*	100 (29.7%)
9. Verify and document administration sequence of drugs in regimen.	238 (71.5%)	32 (9.6%)*	2 (0.6%)*	62 (18.3%)
10. Verify and document correct hazardous drug labeling.	240 (72.0%)	20 (6.0%)*	12 (3.6%)*	62 (18.4%)
11. Ensure and document two individuals verify patient identification.	291 (87.3%)	9 (2.7%)*	10 (3.0%)*	24 (7.0%)

Note: Numbered variables correspond to "Pretreatment Error Prevention" survey (See Appendix C).

\*Impact on practice is considered to have occurred if respondents selected either response option 2 or 3.

Footnotes: Full survey response options:

<sup>1</sup> I consistently performed this behavior prior to course completion and no change was needed.

<sup>2</sup> I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.

<sup>3</sup> I did not perform this behavior prior to course completion and have since started performing the behavior.

<sup>4</sup> I did not perform this behavior prior to course completion and still do not perform it.



Table 3

*Perceived Impact on Practice:**Individual Treatment Administration Error Prevention Behavior Variables (N = 334)*

Treatment Administration Error Prevention Behavior	Consistently performed; no change needed <sup>1</sup>	Sometimes or mostly performed; more aware of need to perform <sup>2*</sup>	Did not perform; have started performing <sup>3*</sup>	Did not perform; still do not perform <sup>4</sup>
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
1. Utilize infusion pump to eliminate gravity infusions.	296 (90.4%)	10 (2.7%)*	0 (0.0%)*	28 (6.9%)
2. Use infusion set-up with immediate access to primary flush and emergency equipment.	257 (77.2%)	25 (7.5%)*	7 (2.1%)*	45 (13.2%)
3. Assess and document administration site and its appearance.	296 (88.9%)	9 (2.7%)*	1 (0.3%)*	28 (8.1%)
4. Assess and document treatment tolerance and any immediate effects.	281 (84.4%)	12 (3.6%)*	2 (0.6%)*	39 (11.4%)

*Note:* Numbered variables correspond to “Treatment Administration Error Prevention” survey (See Appendix C).

\*Impact on practice is considered to have occurred if respondents selected either response option 2 or 3.

*Footnotes:* Full survey response options:

<sup>1</sup> I consistently performed this behavior prior to course completion and no change was needed.

<sup>2</sup> I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.

<sup>3</sup> I did not perform this behavior prior to course completion and have since started performing the behavior.

<sup>4</sup> I did not perform this behavior prior to course completion and still do not perform it.

Table 4

*Perceived Impact on Practice:**Organizational Policy and Procedure Error Prevention Variables (N = 334)*

Policy/Procedure (P&P) Type	P&P already in place; no change needed <sup>1</sup>	Started discussion about P&P revision <sup>2*</sup>	P&P already in place; unsure if change needed <sup>3</sup>	P&P were not and still not in place <sup>4</sup>	Unsure if P&P are in place <sup>5</sup>
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
1. P&P support and detail steps and components in the pretreatment verification process.	159 (47.7%)	130 (39.0%)*	31 (9.1%)	7 (2.1%)	7 (2.1%)
2. P&P support and detail steps and components in the treatment administration process.	172 (51.7%)	122 (36.6%)*	30 (8.7%)	4 (1.2%)	6 (1.8%)
3. P&P support and detail pretreatment and administration documentation requirements.	184 (55.3%)	101 (30.3%)*	36 (10.5%)	4 (1.2%)	9 (2.7%)

*Note:* Numbered variables correspond to “Organizational Error Prevention Policies and Procedures” survey (See Appendix C).

\*Impact on practice is considered to have occurred if respondents selected response option 2.

*Footnotes: Full survey response options*

<sup>1</sup> I know effective policies and procedures were already in place prior to course completion and no change was needed.

<sup>2</sup> I know these policies and procedures were already in place, but I started discussions or approached peers and/or nurse leaders about the need to review or revise specific policies and procedures.

<sup>3</sup> I know these policies and procedures were already in place, but do not know if changes are needed.

<sup>4</sup> I know these policies and procedures were not previously in place and are still not in place.

<sup>5</sup> I am unsure if these policies and procedures are in place.

Table 5

*Perceived Barriers to Individual Practice Change (N = 334)*

Barrier	Frequency (%)
I have not encountered any barriers to initiating change in my own practice or did not need to initiate change in my own practice.	130 (38.9)
I need to find ways to more effectively engage patients in chemotherapy error prevention.	106 (31.7)
I believe the physician and pharmacist are responsible to verify orders to prevent chemotherapy errors.	59 (17.7)
I have mentioned changes to other nurses but they have questioned the changes I want to make.	55 (16.5)
I do not have enough time to make changes in my pretreatment and treatment administration tasks.	39 (11.7)
I am reluctant to change my own practice because it will be different from the practice of other nurses.	23 (6.9)
I am unsure of nursing policies and procedures in my practice setting that may help me to prevent chemotherapy errors.	21 (6.3)
I do not feel the chemotherapy educational program provided enough information about how I can prevent chemotherapy errors.	19 (5.7)
I am unsure what chemotherapy error prevention strategies for nurses are included in guidelines and standards.	17 (5.1)
I believe that using computerized order systems and electronic health records eliminates the risk for chemotherapy errors.	1 (0.3)

*Note:* Participants selected any and all statements that reflected their perception of challenges encountered or anticipated when initiating error prevention change in his/her personal practice (See Appendix C).

Table 6

*Perceived Barriers to Organizational Policy and Procedure Change (N=334)*

<b>Barrier</b>	<b>Frequency (%)</b>
I have not encountered any barriers to initiating change in policies and procedures or did not need to initiate change to policies and procedures.	129 (38.6)
Inadequate staffing and time constraints affect compliance with policies and procedures in my organization.	102 (30.5)
Electronic ordering and documentation systems are not easily changed or are not integrated in my organization.	70 (21.0)
Ongoing education and monitoring for the prevention of errors is lacking in my organization.	59 (17.7)
Policies and procedures in my organization do not or may not include provide best practices for chemotherapy error prevention.	54 (16.2)
Effective interprofessional communication is lacking in my organization.	53 (15.9)
Leaders in my organization lack understanding regarding the need for change.	50 (15.0)
Leaders in my organization lack knowledge regarding error prevention strategies.	49 (14.7)
Leaders in my organization are not receptive to ideas for change.	36 (10.8)
Evidence and resources to validate the need for change in my organization are lacking.	36 (10.8)
My organization does not prioritize chemotherapy error prevention strategies.	32 (9.6)
The culture in my organization makes me reluctant to offer suggestions.	29 (8.7)
Recommending additional error prevention strategies in policies and procedures may lead to a higher risk for punitive action if those tasks are not performed.	22 (6.6)

*Note:* Participants selected any and all statements that reflected their perception of challenges encountered or anticipated when initiating change to organizational policies and procedures, including documentation forms and quality improvement monitoring (See Appendix C).

Table 7

*Individual Pretreatment and Treatment Administration Error Prevention Behavior Variables by Certified and Non-certified Nurses (N = 331) †*

Behavior	Certified Nurses*	Non-certified Nurses**	p value
	Frequency (%)	Frequency (%)	
Pretreatment: Confirm planned treatment education and patient consent for treatment are documented: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	134 (76.6%) 6 (3.4%)* 0 (0.0%)* 35 (20.0%)	109 (69.0%) 16 (10.1%)* 4 (2.5%)* 29 (18.4%)	0.010†
Pretreatment: Review allergies and current list of all medications for potential interactions: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	126 (72.0%) 1 (0.6%)* 2 (1.1%)* 46 (26.3%)	105 (66.5%) 15 (9.5%)* 5 (3.2%)* 33 (20.9%)	<0.001†
Pretreatment: Verify and document actual patient height and weight: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	146 (83.9%) 7 (4.0%)* 1 (0.6%)* 20 (11.5%)	109 (69.9%) 19 (12.2%)* 4 (2.6%)* 24 (15.4%)	0.005†
Pretreatment: Ensure and document order completeness by verifying each drug's name, dose, volume, administration route, administration rate, expiration date, and physical appearance: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	151 (86.8%) 3 (1.7%)* 0 (0.0%)* 20 (11.5%)	120 (76.4%) 13 (8.3%)* 3 (1.9%)* 21 (13.4%)	0.005†
Pretreatment: Verify and document any drug-specific cumulative dose and dose limits: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	84 (48.0%) 24 (13.7%)* 8 (4.6%)* 59 (33.7%)	58 (37.4%) 39 (25.2%)* 19 (12.3%)* 39 (25.2%)	0.001†
Pretreatment: Verify and document correct hazardous drug labeling: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	129 (73.7%) 3 (1.7%)* 7 (4.0%)* 36 (20.6%)	110 (70.1%) 17 (10.8%)* 5 (3.2%)* 25 (15.9%)	0.004†
Pretreatment: Ensure and document that two individuals verify patient identification: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	164 (93.7%) 0 (0.0%)* 1 (0.6%)* 10 (5.7%)	126 (80.3%) 9 (5.7%)* 9 (5.7%)* 13 (8.3%)	<0.001†

Table 7 (continued)

Behavior	Certified Nurses*	Non-certified Nurses**	p value
	Frequency (%)	Frequency (%)	
Treatment Administration: Assess and document administration site and its appearance: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	162 (93.1%) 0 (0.0%)* 0 (0.0%)* 12 (6.9%)	133 (84.2%) 9 (5.7%)* 1 (0.6%)* 15 (9.5%)	0.002†
Treatment Administration: Assess and document treatment tolerance including any immediate effects: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	160 (91.4%) 0 (0.0%)* 1 (0.6%)* 14 (8.0%)	121 (76.6%) 12 (7.6%)* 1 (0.6%)* 24 (15.2%)	<0.001†

†All p values are associated with Fisher's Exact Test of association between the row and columns variables. Only statistically significant results at the 0.01 level are reported.

\*Certified nurses = Participants with reported OCN®, AOCN®, AOCNS®, AOCNP®, CBCN®, BMTCN®, CPHON® certification.

\*\*Non-certified nurses = No professional oncology certification reported.

\*\*\*Impact on practice is considered to have occurred if respondents selected either response option 2 or 3.

Footnotes: Full survey response options

<sup>1</sup> I consistently performed this behavior prior to course completion and no change was needed.

<sup>2</sup> I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.

<sup>3</sup> I did not perform this behavior prior to course completion and have since started performing the behavior.

<sup>4</sup> I did not perform this behavior prior to course completion and still do not perform it.

Table 8

*Individual Pretreatment and Treatment Administration Error Prevention Behavior Variables by Inpatient and Outpatient Nurses (N = 325) †*

Behavior	Inpatient Nurses*	Outpatient Nurses**	<i>p</i> value
	Frequency (%)	Frequency (%)	
Pretreatment: Verify and document any drug-specific cumulative dose and dose limits: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	52 (35.6%) 32 (21.9%)* 17 (11.6%)* 45 (30.8%)	89 (49.7%) 28 (15.6%)* 9 (5.0%)* 53 (29.6%)	0.004†
Treatment Administration: Use infusion set-up with immediate access to primary flush line and emergency equipment: ●Consistently performed; no change needed <sup>1</sup> ●Sometimes performed; more aware of need to perform <sup>2***</sup> ●Did not perform; have started performing <sup>3***</sup> ●Did not perform; still do not perform <sup>4</sup>	103 (70.1%) 17 (11.6%)* 4 (2.7%)* 23 (15.6%)	152 (84.0%) 7 (3.9%)* 2 (1.1%)* 20 (11.0%)	0.002†

†All *p* values are associated with Fisher's Exact Test of association between the row and columns variables. Only statistically significant results at the 0.01 level are reported.

\*Inpatient nurses = Participants reporting primary chemotherapy care setting as inpatient oncology, inpatient non-oncology, intensive care, or bone marrow transplant.

\*\*Outpatient nurses = Participants reporting primary chemotherapy care setting as outpatient oncology or infusion center.

Not included = Hospice/palliative, long-term care, home care settings due to very limited participants reporting these settings.

\*\*\*Impact on practice is considered to have occurred if respondents selected either response option 2 or 3.

Footnotes: Full survey response options:

<sup>1</sup> I consistently performed this behavior prior to course completion and no change was needed.

<sup>2</sup> I sometimes or mostly performed this behavior prior to course completion and am now more aware of the need to perform it.

<sup>3</sup> I did not perform this behavior prior to course completion and have since started performing the behavior.

<sup>4</sup> I did not perform this behavior prior to course completion and still do not perform it.

Table 9

*Perceived Barriers to Individual and Organizational Change by Age and by Years of Nursing Practice †*

Groups of Nurses	One or More Barriers to Individual Practice Change Identified		One or More Barriers to Organizational Policy and Procedure Change Identified	
	Frequency (%)	<i>p</i> value	Frequency (%)	<i>p</i> value
<b>Age of Nurses</b>		0.001†		0.005†
20-29 Years of Age (n=60)	49 (82%)		47 (78%)	
30-39 Years of Age (n=91)	57 (63%)		59 (65%)	
40-49 Years of Age (n=79)	39 (50%)		46 (58%)	
≥ 50 Years of Age (n=103)	59 (57%)		53 (52%)	
<b>Years of Nursing Practice</b>		0.005†		0.005†
≤ 3 Years in Nursing (n=61)	46 (75%)		44 (72%)	
4-14 Years in Nursing (n=131)	83 (63%)		87 (66%)	
≥ 15 Years in Nursing (n=139)	72 (52%)		71 (51%)	

†All *p* values are associated with Fisher's Exact Test of association between the row and columns variables. Only statistically significant results at the 0.01 level are reported.

*Note:* Participants selected any and all statements that reflected their perception of challenges encountered or anticipated when initiating error prevention change in his/her personal practice (See Appendix C).